AGRICULTURE FOR BEGINNERS

BURKETT, STEVENS AND HILL

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THE END OF THE HARVEST

AGRICULTURE FOR BEGINNERS

BY

CHARLES WILLIAM BURKETT
Professor of Agriculture

AND

FRANK LINCOLN STEVENS
Professor of Biology

AND

DANIEL HARVEY HILL
Professor of English

IN THE
North Carolina College of Agriculture and
Mechanic Arts

Boston, U.S.A., and London
GINN & COMPANY, PUBLISHERS
The Athenæum Press
1903

PREFACE

The authors of this little book believe that there is no line of separation between the science of agriculture and the practical art of agriculture. They are assured by experience that agriculture is eminently a teachable subject. They are convinced that the theory and practice of agriculture can be taught at one and the same time. They see no difference between teaching the child the fundamental principles of farming and teaching the same child the fundamental truths of arithmetic, geography, or grammar. They hold that a youth should be trained for the farm just as he is trained for any other occupation.

If they are right in these views, the training must begin in the public schools. This is true for two reasons:

1. It is universally admitted that aptitudes are developed, tastes acquired, life habits formed during the years that a child is in the public school. Hence, during these important years, every child intended for the farm should be taught to know and love nature, should be led to form habits of observation, and should be required to begin a study of those great laws upon which agriculture is based. A training like this would go far towards making his life-work profitable and delightful.

2. Most boys and girls reared on a farm get no educational training except that given in the public schools. If, then, the truths that unlock the doors of nature are not taught in the public schools, "Nature and nature's laws will always be hid in night" to a majority of our bread winners. They must still in ignorance and hopeless drudgery tear their bread from a reluctant soil.

The authors return hearty thanks to Professor Thomas F. Hunt, Ohio State University; Professor Augustine D. Selby, Ohio Experiment Station; Professor W. F. Massey, North Carolina Experiment Station; and Professor Franklin Sherman, Jr., State Entomologist of North Carolina, for aid in proof-reading. For valuable assistance in securing illustrations grateful acknowledgment is made to the German Kali Works, New York; Mr. Alexis Everett Frye, Cambridge, Mass.; Professor Byron D. Halsted, New Brunswick, N.J.; Director R. J. Redding, Experiment, Ga.; Director I. P. Roberts, Cornell University; Vermont Farm Machine Company, Bellows Falls; the Agricultural Experiment Station, Cornell University; the Indiana Experiment Station, Lafayette; Mr. H. L. Bolley, North Dakota Agricultural College; Mr. J. F. Kemp, Columbia University; Mr. Clarence M. Weed, New Hampshire College of Agriculture and the Mechanic Arts; and the United States Department of Agriculture. Detailed credit is given in connection with many of the illustrations.

THE AUTHORS.

JUNE, 1903.

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TO THE TEACHER

An earnest teaching of this book will, we believe, add to the attractiveness of your course of study. Do not hesitate to enter heartily into the new subject. To teach agriculture you need not feel that you must be an authority on all questions arising in this broad field. To teach some agriculture one need not know all agriculture. If you know even a few valuable facts, methods, or principles that will make life on the farm easier, that will make the farm more beautiful, more productive, and more profitable, you will be doing good by imparting these methods and these principles.

Lead the pupils out into the field, make simple experiments before them, and have them also perform experiments. Let them learn directly from nature: a fact gained at first hand will linger in the mind long after mere second-hand book knowledge has departed. Teach by observation and experiment. The young mind grasps the concrete but wearies with the abstract.

You will find in the practical exercises many suggestions as to experiments that you can make with your class. Do not neglect these. They will be the life of your work. In many cases it will be best to perform the experimental or observational work first, and turn to the text later to amplify the pupil's knowledge.

Although the authors have arranged this book in a logical order, they hope that teachers will feel free to teach each topic in the season best suited to its study.

TO THE PUPIL

Consult the glossary in the back of this book for the meanings of all hard words.

Try to get for your school library every farm bulletin issued by the United States Department of Agriculture and as many bulletins as possible from different State Experiment Stations. These bulletins cost nothing and are mines of practical and interesting information.

Perform all the suggested experiments for yourself. Do not be content to watch your teacher or your fellow-students perform these experiments. First-hand work gives expertness, accuracy, interest, knowledge, power.

Above all, learn of nature. At first she is a shy and silent teacher, but on better acquaintance she will talk to you in many tongues.

AGRICULTURE FOR BEGINNERS

CHAPTER I

THE SOIL

SECTION I — ORIGIN OF THE SOIL

The word *soil* occurs many times in this little book. In its agricultural sense this word is used to describe the thin layer of surface earth that, like some great blanket, is tucked around the wrinkled and age-beaten form of our globe. The harder and colder earth under this surface layer is called the *subsoil.* It should be remembered, however, that in waterless and sun-dried countries there seems little difference between the soil and the subsoil.

Plants, insects, birds, beasts, men, — all alike are fed on what grows in this thin layer of soil. If some wild flood in sudden wrath could sweep into the ocean this earth-wrapping soil, food would soon become as scarce as it was in Samaria when mothers boiled and ate their sons. The face of the earth as we now see it daintily robed in grass, or uplifting waving acres of corn, or even naked, water-scarred, and disfigured by man's neglect, is very different from what it was in its earliest days. How was it then? How did the soil originate?

Learned men believe that at first the surface of the earth was solid rock. How were these rocks changed into workable soil? Occasionally a curious boy picks up a rotten stone, squeezes it, and finds his hands filled with dirt, or soil. Now, just as the boy crumbled with his fingers this single stone, the great forces of nature with boundless patience crumbled, or, as it is called, disintegrated, the early rock mass. These simple but giant-strong agents that beat the rocks into powder with a club-like force a million fold more powerful than the club force of Hercules were chiefly: (1) heat and cold; (2) water, frost, and ice; (3) a very low form of vegetable life; and (4) tiny animals, if such minute bodies can be called animals. In some cases these forces acted singly; in others, all acted together to rend and crumble the unbroken stretch of rock. Let us glance at some of the methods used by these skilled world makers.

Heat and cold are working partners. You remember that most hot bodies shrink, or contract, on cooling. These early rocks were hot. As the outside shell of rock cooled from exposure to air and moisture, it contracted. This shrinkage of the rigid rim, of course, broke many of the rocks, and here and there left cracks, or fissures. In these fissures water collected, froze, and, as freezing water expands with irresistible power, the expansion still further broke the rocks to pieces. The smaller pieces again, in the same way, were acted upon by frost and ice, and again crumbled. This process has continued more or less until this day.

Running water was another giant soil former. If you would understand its action, observe some usually sparkling

stream just after a washing rain. The clear waters are uglied and discolored by mud washed in from the surrounding hills. As though disliking their muddy burden, the waters strive to throw it off. Here, as low banks offer chance, they run out into shallows and drop some of it. Here, as they pass some quiet pool, they deposit more. At last they reach the still water at the mouth,

Fig. 1. Rock marked by the Scraping of a Glacier over it

and there they shake off the last of their mud load, and often form of it little islands, or deltas. In the same way, bearing acres of soil in their waters, mighty rivers like the Amazon, the Mississippi, and the Hudson, when they are swollen by rain, sweep to the seas. Some soil they scatter over the lowlands as they whirl seaward; the rest they deposit in deltas at their mouths. It is estimated that the Mississippi carries to the ocean each year enough

soil to cover a square mile of surface to a depth of two hundred and sixty-eight feet.

The early brooks and rivers, instead of bearing mud, ran oceanward bearing ground stone that either they themselves had worn from the rocks by ceaseless fretting, or bearing stones that other forces had dislodged from parent nest. The large pieces were whirled from side to side, beaten against one another, or against bed rock, until they were ground finer. The rivers distributed this rock soil just as the later rivers distribute muddy soil. Year after year for ages the moving waters ground against the rocks. Vast were the waters; vast the number of years; vast the results.

Glaciers were another soil-producing agent. Glaciers, as Stockbridge says, are but "streams frozen and moving slowly but irresistibly onwards, down well-defined valleys, grinding and pulverizing the rock masses detached by the force and weight of their onslaught." Where and how were these glaciers formed?

Once a great part of upper North America was a vast sheet of ice. Whatever moisture fell from the sky fell as snow. No one knows what made this long winter of snow, but we do know that snows piled on snows until mountainlike masses reared their heads above the rocks. The lower snow was by the pressure of the upper packed into ice masses. By and by some change of climate caused these masses of ice to break up somewhat and to move to the south and west. These moving masses, carrying rock and frozen earth, ground them to powder. King thus describes the stately movement of these snow mountains: "Beneath the bottom of this slowly moving sheet of pressure-plastic ice, which with more or less difficulty kept itself

conformable with the face of the land over which it was riding, the sharper outstanding points were cut away and the deeper river cañons filled in. Desolate and rugged rocky wastes were thrown down and spread over with rich soil."

The joint action of air, moisture, and frost was still another agent of soil making. This action is called *weathering*. Whenever you have noticed the outside rocks of a spring house, you have noticed that tiny bits are crumbling

FIG. 2. GROUND ROCK AT END OF A GLACIER

from the face of the rocks, and adding little by little to the soil. This is a slow way of making additions to the soil. It is estimated that it would take 728,000 years to wear away limestone rock to a depth of thirty-nine inches. But when you recall the countless years through which the weather has striven against the rocks, you can readily understand that its never-wearying activity has added immensely to the soil.

In the rock soil formed in these various ways, and indeed on the rocks themselves, tiny plants that live on

food taken from the air began to grow. They grew just as you now see mosses and lichens grow on the surface of rocks. The decay of these plants added some fertility to the newly formed soil. The life and death of each succeeding generation of these lowly plants added to the soil matter accumulating on the rocks. Slowly but unceasingly the depth of soil increased until higher vegetable forms could flourish and add their dead bodies to the deepening soil. This vegetable addition to the soil is generally known as *humus*.

In due course of time low forms of animal life came to live on these plants, and in turn by their work and their death to aid in making a soil fit for the plowman.

Thus with a deliberation that fills man with awe, the powerful forces of nature splintered the rocks, crumbled them like a potter's vessel, filled them with plant food, and turned their flinty grains into a soft, snug home for vegetable life.

SECTION II — TILLAGE OF THE SOIL

A good many years ago there lived in England a man by the name of Jethro Tull. He was a farmer and a most successful man in every way.

His claim to fame comes from his teaching the English people and the world the value of thorough tillage of the soil. Before and during his time, farmers did not till the soil very intelligently. They simply prepared the seed bed in a careless manner, as a great many farmers do to-day, and when the crops were gathered the yields were not large.

Jethro Tull centered attention on the important fact that careful and thorough tillage increases the available plant food in the soil. He did not know why his crops were better when they were frequently and thoroughly tilled: but he

FIG. 3. SLOPE TO WATER SHOWS SOIL WEATHERED FROM FACE OF CLIFF

knew the fact. He explained the fact by saying that "tillage is manure." We have since learned the reason for the truth that Tull taught, and, while his explanation was incorrect, the practice that he was following was excellent. The stirring

of the soil enables the air to circulate through it freely, and permits a breaking down of the complex compounds that contain the elements necessary to plant growth.

You have seen how the air helps to crumble the stone and brick in old buildings. It does the same with soil if permitted to circulate freely through it. The agent of the air that chiefly performs this work is called carbonic acid

FIG. 4. A BOUNTIFUL CROP BY TILLAGE ALONE

gas, and this gas is one of the greatest helpers the farmer has in carrying on his work. We must not forget that in soil preparation the air is just as important as any of the tools and implements used in cultivation.

For most soils a two-horse plow is necessary to break up and pulverize the land.

If the soil is fertile and if deep plowing has always been done, good crops will result, other conditions being favorable. If, however, the tillage is poor, scanty harvests will always result.

When a soil has been neglected and when it is hard and dead, shallow plowing will prove more satisfactory. But a shallow soil can always be improved by properly deepening it. The principle of greatest importance in soil preparation is the gradual deepening of the soil in order that plant roots may have more comfortable homes. If the farmer has been accustomed to plow but four inches deep, he should adjust the plow so as to turn five inches at the next plowing, then six, and so on until the seed bed is nine or ten inches deep. This gradual deepening will not injure the soil but will put it quickly in good physical condition. If to good tillage rotation of crops be added, the soil will become more fertile with each succeeding year.

The plow, harrow, and roller are all necessary to good tillage and a proper preparation of the seed bed. The soil must be compact and clods of all sizes crushed. Then the air circulates freely, and paying crops are the rule and not the exception.

EXERCISE

1. What tools are used in tillage?
2. Why should a poor and shallow soil be plowed shallow?
3. Why should a poor and shallow soil be well compacted before sowing the crop?
4. Explain the value of a circulation of air in the soil.
5. What causes iron to rust?
6. Why is a two-horse turning plow better than a one-horse plow?
7. Where will clods do the least harm, — on top of the soil or below the surface?
8. Do plant roots penetrate clods?
9. Are earthworms a benefit or an injury to the soil?
10. Name three things that a plow does.

SECTION III — THE MOISTURE OF THE SOIL

Did any one ever explain to you how important water is to the soil or tell you why it is so important? Often, as you know, crops entirely fail because there is not enough water in the soil for the plants to drink. How necessary is it, then, that the soil be kept in the best possible condition to catch and hold enough water to carry the plant through dry, hot spells! Perhaps you are ready to ask, "How does the mouthless plant drink its stored-up water?"

The plant gets all its water through its roots. You have seen the tiny fibrous roots of a plant spreading all about in fine soil; they are down in the ground taking up plant food and water for the stalk and leaves above. The water, carrying plant food with it, rises, by means of a peculiar process, through roots and stems.

The plants use the food for building new tissue, that is, for growth. The water passes out through the leaves into the air. When the summers are dry and hot and there is but little water in the soil, the leaves shrink up. This is simply a method they have of keeping the water from passing rapidly off into the air. I am sure you have seen the corn stalks all shriveled on very hot days. This shrinkage is nature's way of diminishing the current of water that is steadily passing through the plant.

A thrifty farmer will try to keep his soil in such good condition that it will have a supply of water in it for growing crops when dry and hot weather comes. He can do this by deep plowing, by subsoiling, by adding any kind of decaying vegetable matter to the soil, and by growing crops that can be tilled frequently.

Fig. 5. The Right Way to plow

The soil is a great storehouse for moisture. After the clouds have emptied their waters into this storehouse, the water of the soil comes to the surface, where it is evaporated into the air. The water comes to the surface in just the same way that oil rises in a lamp wick. This rising of the water is called *capillarity*.

It is necessary to understand what is meant by this big word. If into a pan of water you dip a glass tube, the water inside the tube rises above the level of the water in the pan. The smaller the tube the higher will the water rise. The greater rise inside is perhaps due to the fact that the glass attracts the particles of water more than the particles of water attract one another. Now apply this principle to the soil.

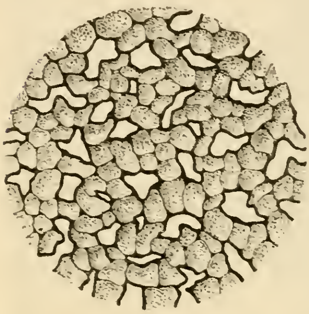


FIG. 6. AN ENLARGED VIEW OF A SECTION OF MOIST SOIL SHOWING AIR SPACES AND SOIL PARTICLES

The soil particles have small spaces between them, and these spaces act just as the tube does. When the water at the surface is carried away by drying winds and warmth, the water deeper in the soil rises through these soil spaces. In this way water is brought from its soil storehouse as plants need it.

Of course, when this water reaches the surface, it evaporates. If we want to keep it for our crops, we must prepare a trap to hold it. Nature has shown us how this can be done. Pick up a plank lying on the ground. Under the plank the soil is wet, while the soil not covered by the plank is dry. Why? Capillarity brought the water to the surface. The plank, however, keeping away wind and

warmth, acted as a trap to hold the moisture. Now of course a farmer cannot set a trap of planks over his fields, but he can make a trap of dry earth, and that will do just as well.

When a crop like corn or cotton is cultivated, the fine, loose dirt stirred by the cultivating plow will make a mulch

FIG. 7. APPARATUS FOR TESTING RETENTION OF WATER BY DIFFERENT SOILS

that serves to keep water in the soil in the same way the plank kept moisture under it. The mulch helps to absorb the rains and prevents the water from running off the surface. Frequent cultivation, then, is one of the best possible ways of saving moisture. Hence the planter who most frequently stirs his soil in the growing season, and especially in seasons of drought, reaps, other things being equal, a more abundant harvest than if tillage were neglected.

EXERCISE

1. Why is the soil wet under a board or under straw?
2. Will a soil that is fine and compact produce better crops than one that is loose and cloddy? Why?
3. Since the water which a plant uses comes through the roots, can the morning dew afford any assistance?
4. Why are weeds objectionable in a growing crop?
5. Why does the farmer cultivate growing corn and cotton?

SECTION IV—HOW THE WATER RISES IN THE SOIL

When the hot, dry days of summer come, the soil depends upon the subsoil, or undersoil, for the moisture that it must furnish its growing plants. The water was stored in the soil during the fall, winter, and spring months when there was plenty of rain. If you dig down into the soil when everything is dry and hot, you will reach the cool, moist undersoil. It becomes more moist as you go deeper into the soil.

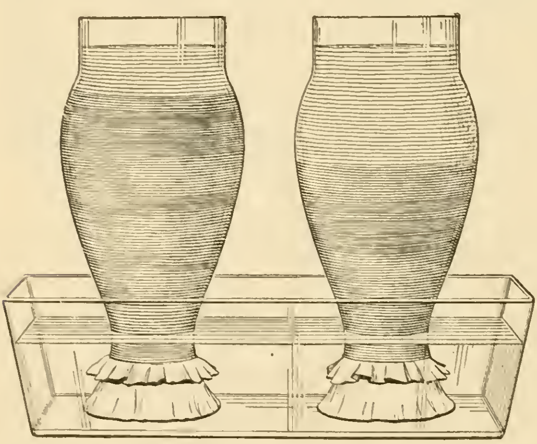


FIG. 8. USING LAMP CHIMNEYS TO SHOW RISE OF WATER IN SOIL

Now the roots of plants go down into the soil for this moisture, because they need the water to carry the plant food up into the stems and leaves.

You can see how the water rises in the soil by performing a simple experiment.

EXPERIMENT

Take a lamp chimney and fill it with dry, fine dirt. The dirt from a road or a field will do. Tie over the bottom of the lamp chimney a piece of cloth or a pocket handkerchief, and place this end in a shallow pan of water. If the soil in the lamp chimney is clay and well packed, the water will quickly rise to the top.

By filling three or four lamp chimneys with as many different soils, the pupil will see that the water rises more slowly in some than in others.

Now take the water pans away, and the water in the lamp chimneys will gradually evaporate. Study for a few days the effect of this evaporation on the several soils.

SECTION V — DRAINING THE SOIL

A wise man was once asked, "What is the most valuable improvement ever made in agriculture?" He answered, "Drainage." Often soils unfit for crop production because of the free water in them are by drainage rendered the most valuable of farming land.

The benefits of drainage are as follows:

1. It deepens the subsoil by removing unnecessary water from the spaces between the soil particles. This admits air. Then the oxygen which is in the air, by aiding decay, prepares plant food for vegetation.

2. It makes the surface, or topsoil, deeper. It stands to reason that the deeper the soil the more plant food becomes available for plant use.

3. It improves the texture of the soil. Wet soil is sticky. Drainage makes this sticky soil crumble and fall apart.

4. It prevents washing.

5. It increases the porosity of soils and permits roots to go deeper into the soil for food and moisture.

6. It increases the warmth of the soil.

7. It permits earlier working in spring and after rains.

FIG. 9. LAYING A TILE DRAIN

8. It favors the growth of germs which change the unavailable nitrogen of the soil into nitrates; that is, into the form most useful to plants.

9. It enables plants to resist drouth better because the roots go into the ground deeper early in the season.

A soil that is hard and wet will not grow good crops. The nitrogen-gathering crops will store the greatest quantity of nitrogen in the soil when the soil is open to the

free circulation of the air. These valuable crops cannot do this when the soil is wet and cold.

Sandy soils with sandy subsoils do not need artificial drainage; these soils are naturally drained. With clay soils it is different. It is very important to remove the stagnant water in them and to let the air in.

When land has been properly drained, the other steps in improvement are easily taken. When soil is dried and mellowed by proper drainage, then commercial fertilizers, barnyard manure, cowpeas and clover can each most readily do its great work of improving the texture of the soil and of making it a cosy home for plants to grow in.

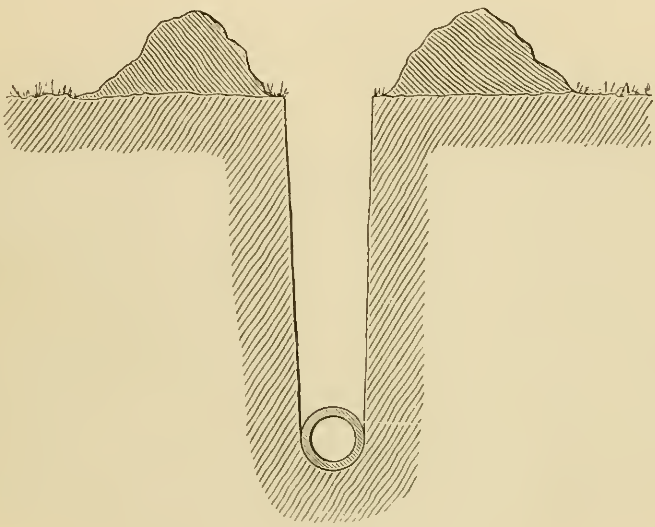


FIG. 10. A TILE IN POSITION

Tile Drains. Tile drains are the best and cheapest that can be used. It would not be too strong to say that draining by tiles is the perfection of drainage. Thousands of practical tests in this country have demonstrated the value of tile draining for the following reasons;

1. Good tile drains properly laid last for years and do not fill up.

2. They furnish the cheapest possible means of removing excess of water from the soil.

3 They are out of reach of all cultivating tools.

4. Surface water in filtering through the soil leaves its nutritious elements for plant growth.

EXPERIMENTS

To show the Effect of Drainage. Take two tomato cans and fill both with the same kind of soil. Puncture several holes in the bottom of one to drain the soil above and to admit air circulation. Leave the other unpunctured. Plant seeds of any kind in both cans and keep in a warm place. Add every third day equal quantities of water. Let seeds grow in both and observe the difference in growth for two or three weeks.

To show the Effect of Air in Soils. Take two tomato cans; fill one with soil that is loose and warm, and the other with wet clay or muck from a swampy field. Plant a few seeds of the same kind in each and observe how much better the dry, warm, open soil is for growing farm crops.

SECTION VI — IMPROVING THE SOIL

We hear a great deal nowadays about the exhaustion or wearing out of the soil. Many uncomfortable people are always declaring that our lands will no longer produce profitable crops, and hence that farming will no longer pay.

Now it is true, unfortunately, that much land has been robbed of its fertility, and, because this is true, we should be deeply interested in everything that pertains to soil improvement.

When our country was first discovered and trees were growing everywhere, we had virgin soils, or new soils that were rich and productive because they were filled with vegetable matter and plant food. There are not many virgin soils now because the trees have been cut off the best lands, and these lands have been farmed so long

FIG. 11. CLOVER IS A SOIL IMPROVER

without much attention that the vegetable matter and available plant food have been largely used up. Now that fresh land is scarce, it is very necessary to restore fertility to these exhausted lands. What are some of the ways in which this can be done?

There are several things to be done in trying to reclaim worn-out land. One of the first of these is to till the land

well. Many of you may have heard the story of the dying father who called his sons about him and whispered feebly, "There is great treasure hidden in the garden." The sons could hardly wait to bury their dead father before, thud, thud, thud, their picks were going in the garden. Day after day they dug; they dug deep; they dug wide. Not a foot of the crop-worn garden escaped the probing of the pick as the sons feverishly searched for the expected treasure. But no treasure was found.

"Let us not lose every whit of our labor; let us plant this pick-scarred garden," said the eldest. So the garden was planted. In the fall the hitherto poor garden yielded a harvest so bountiful, so unexpected, that the meaning of their father's words dawned upon them. "Truly," they said, "a treasure was hidden there. Let us seek it in all our fields."

The story applies as well to-day as it did when it was first told. Deep breaking of the soil, frequent and intelligent tillage,— these are the foundations of soil restoration.

Along with good tillage must go hillside ditches, or terraces, and good drainage. The ditches, or terraces, are to prevent heavy rains from washing the soil and carrying away plant food. Drainage is to act with good tillage in allowing air to circulate between the soil particles and to arrange plant food so that plants can use it.

Then we must add humus, or vegetable matter, to the soil. You remember that virgin soils contained a great deal of vegetable matter and plant food, but by the continuous growing of crops like wheat, corn, and cotton, and by constant shallow tillage, both humus and plant food have been used up. Consequently much of our cultivated soil to-day is hard and dead.

There are three ways of adding humus and plant food to this lifeless land: the first way is to apply barnyard manure (to adopt this method means that livestock raising must be a part of all farming); the second way is to adopt rotation

FIG. 12

Feeding swine on this worn-out field and then tilling it made the field productive

of crops, and occasionally to plow under crops like clover and cowpeas; the third way is to apply commercial fertilizers.

Then, to summarize: if we want to make our soil better year by year, we must cultivate well, drain well, and in the most economical way add humus and plant food.

EXPERIMENT

Select a small area of ground at your home and divide it into four sections, as shown in the following sketch:

On Section *A* apply barnyard manure; on Section *B* apply commercial fertilizers; on Section *C* apply nothing, but till well; on Section *D* apply nothing, and till very poorly.

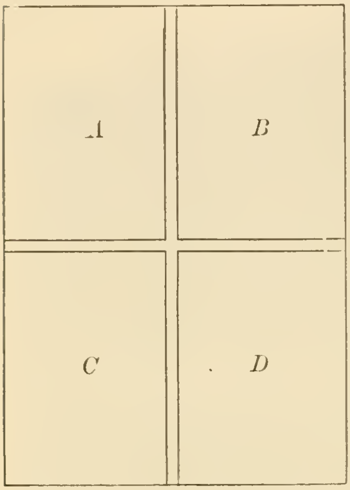


Fig. 13

A, *B*, and *C* should all be thoroughly plowed and harrowed. Then add barnyard manure to *A*, commercial fertilizers to *B*, and harrow *A*, *B*, and *C* at least four times until the soil is mellow and fine. *D* will most likely be cloddy, like many fields that we often see. Now plant on each plat some crop like cotton, corn, or wheat. When the plats are ready to harvest, measure the yield of each and determine whether the increased yield of the best plats has paid for the outlay for tillage and manure. The pupil will be much interested in the results obtained from the first crop.

Now follow a system of crop rotation on the plats. Crimson clover can follow corn or cotton; and cowpeas, wheat. Then determine the yield of each plat for this second crop. By following these plats for several years and increasing the number, the pupils will learn many things of greatest value.

SECTION VII — MANURING THE SOIL

In the early days of our history when the soil was new and rich, we were not compelled to use large amounts of manures and fertilizers. Yet our histories speak of an Indian named Squanto who came into one of the New England colonies and showed the colonists how, by planting a fish in each hill of corn, they could obtain larger yields.

If people, in those days with new and fertile soils, could use manures profitably, how much more ought we to use them in our time when soils have lost their virgin fertility, when the plant food in the soil has been exhausted by years and years of cropping!

To sell year after year all the produce grown on land is a sure way to ruin it. If, for example, the richest land is planted every year in cotton, and no cotton seed, cotton-seed meal, or other fertilizer returned to the soil, the land so treated will of course soon become too poor to grow any crop. If, on the other hand, the seed from the cotton or the meal from the seed is fed to stock, and the manure from the stock returned to the soil, the land will be kept rich. Hence those farmers who sell, not such raw products as cotton, corn, wheat, oats, clover, but who market articles made from these raw products, find it easier to keep their land fertile. For illustration: if instead of selling hay, farmers feed it to sheep and sell wool; if instead of selling cotton seed, they feed its meal to cows, and sell milk and butter; if instead of selling stover, they feed it to beef cattle, they get a good price for products and in addition have all the manure needed to keep their land productive and increase its value each succeeding year.

1 2 3

Fig. 14. Relation of Humus to Growth of Corn

(1) clay subsoil; (2) same, with fertilizer; (3) same, with humus

If we wish to keep up the fertility of our lands, we should not allow anything to be lost from our farms. All the manures, straw, roots, stubble, healthy vines—in fact everything decomposable, should be plowed under or used as a top dressing. Especial care should be taken in storing manure. It should be carefully protected from sun and rain. If a farmer has no shed under which to keep his manure, he should scatter the manure on his fields as fast as it is made.

He should understand also that liquid manure is of more value than solid, because that important plant food, nitrogen, is found almost wholly in the liquid portion. Some of the phosphoric acid and considerable amounts of the potash are also found in the liquid manure. Hence economy requires that none of this escape either by leakage or by fermentation in the stables. Sometimes one can detect the smell of ammonia in the stable. This ammonia is formed by the decomposition of the liquid manure, and its loss should be checked by sprinkling some gypsum (land plaster) or muck over the stable floor.

On many farms it is desirable to buy fertilizers to supplement the manure made upon the farm. In this case it is helpful to understand the composition, source, and availability of the various substances composing commercial fertilizers. The three most valuable things in commercial fertilizers are nitrogen, potash, and phosphoric acid.

The nitrogen is obtained from (1) nitrate of soda mined in Chile, from (2) ammonium sulphate — a by-product of the gas works, from (3) dried blood and other by-products of the slaughter-houses, and from (4) cotton-seed meal. Nitrate of soda is soluble in water and may therefore be washed away

before being used by plants. For this reason it should be applied in small quantities and at intervals of a few weeks.

Potash is obtained in Germany, where it is found in several forms. It is put upon the market as muriate of

FIG. 15. THE COTTON PLANT WITH AND WITHOUT FOOD

In left top pot, no plant food; in left bottom pot, plant food scanty; in both right pots, all elements of plant food present

potash, sulphate of potash, kainit, which contains salt as an impurity, and in other impure forms. Potash is found also in *unleached* wood ashes.

Phosphoric acid is found in various rocks of Tennessee, Florida, and South Carolina, and also to a large extent in

bones. The rocks or bones are usually treated with sulphuric acid. This treatment changes the phosphoric acid into a form available for plant use.

These three kinds of plant food are ordinarily all that we need to supply. In some cases, however, lime has to be added. Besides being a plant food itself, lime acts beneficially on most soils by improving their physical structure; by sweetening the soil, thereby aiding the little living germs called bacteria; by hastening the decay of organic matter; and by liberating the potash that is locked up in the soil.

CHAPTER II

THE SOIL AND THE PLANT

SECTION VIII — ROOTS

You have perhaps observed the regularity of arrangement in twigs and branches. Now pull up the roots of some plant, as for example sheep sorrel, Jimson weed, or some other plant. Note the branching of the roots. In these there is no such regularity as is seen in the twig. Trace the rootlets to their finest tips. How small, slender, and delicate they are! Still we do not see the finest of them, for in taking the plant from the ground we tore them away. In order to see the real construction of a root we must grow one so that we may examine it uninjured. To do this, sprout some oats in a germinator and allow them to grow till they are two or more inches high. Now examine the roots and you will see very fine hairs, similar to those shown in the accompanying figure, forming a fuzz over the surface of the roots near the tips. This fuzz is made of small hairs standing so close together that there are often as many as 38,200 on a single square

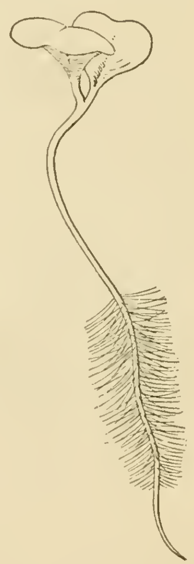


FIG. 16. ROOT HAIRS ON A RADISH

inch. Fig. 17 shows a cross section, or sliced-off portion of a root, very highly magnified. You can see how the root hairs extend from the root in every direction. Fig. 18 shows a single root hair very greatly enlarged, with particles of sand sticking to it.

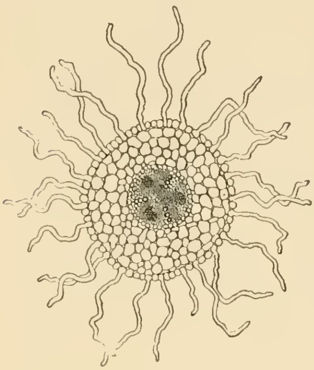


FIG. 17. A SLICE OF A ROOT
Highly magnified

These hairs are the root's feeding organs, and they are formed only very near the tips of the finest roots. You see that the large, coarse roots that you are familiar with have nothing to do with *absorbing* plant food from the soil. They serve merely to *conduct* the sap and nourishment from the root hairs to the tree.

When you apply manure or other fertilizer to the tree, remember that it is far better to supply the fertilizer to the roots that are at some distance from the trunk, for such roots are the real feeders. The plant food in the manure soaks into the soil and immediately reaches the root hairs. You can understand this better by studying the distribution of the roots of an orchard tree, shown in Fig. 19. There you can see that the fine tips are found at a long distance from the main trunk.

FIG. 18. A ROOT HAIR WITH PARTICLES OF SOIL STICKING TO IT

You can now readily see why it is that plants usually wilt when they are transplanted. The fine, delicate root hairs are then broken off, and the plant can keep up its food and water supply but poorly until new hairs

have been formed. While these are forming, water has been evaporating from the leaves, and consequently the plant is insufficiently supplied, and droops.

Would you not conclude that it is very poor farming to till deeply any crop after the roots have extended between

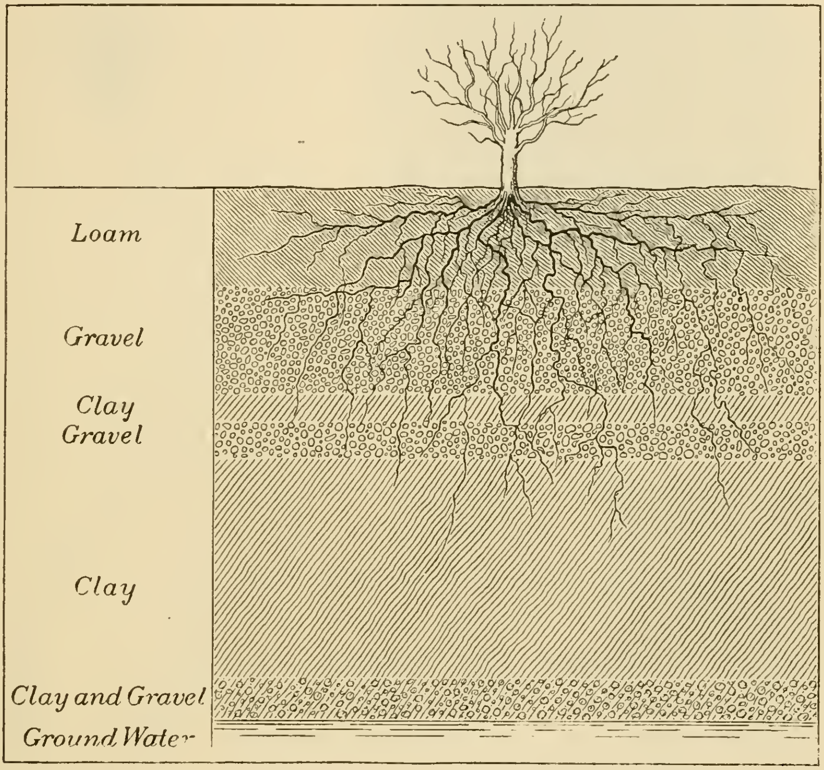


FIG. 19. DISTRIBUTION OF APPLE-TREE ROOTS

the rows far enough to be disturbed by the plow or cultivator? In cultivating between corn rows, for example, if you find that you are disturbing fine roots, you may be sure that you are breaking off millions of root hairs from each plant, and hence are doing harm rather than good. Fig. 20 shows how the roots from one corn row intertangle

with those of another. You see at a glance how many of these roots would be destroyed by deep cultivation. Stirring the upper inch of soil when the plants are well grown

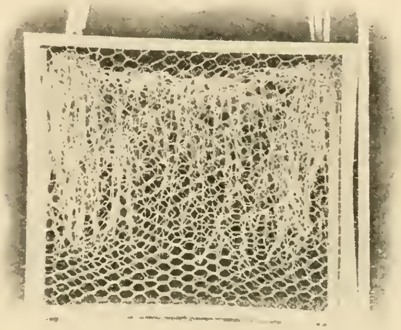


FIG. 20. CORN ROOTS REACH FROM ROW TO ROW

answers the ends of tillage and does no injury to the roots.

A deep soil is much better than a shallow soil, as its depth makes it just so much easier for the roots to seek deep food. Fig. 21 illustrates well how far down into the soil the alfalfa roots go.

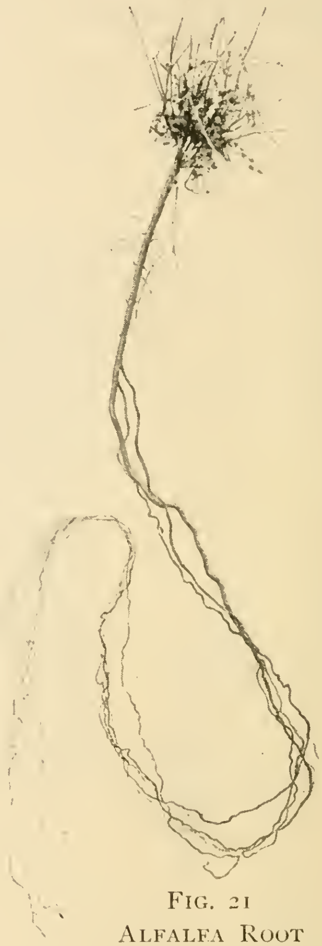


FIG. 21
ALFALFA ROOT

EXERCISE

Dig up the roots of several cultivated plants and weeds and compare them. Do you find some that are fine or fibrous? some fleshy like the carrot? The dandelion is a good example of a tap root. Tap roots are deep feeders. Examine very carefully the roots of a medium-sized corn plant. Sift the dirt away very gently so as to

loosen as few roots as possible. How do the roots compare in area with the part above the ground? Try to trace a single root of the corn plant from the stalk to its very tip. How long are the roots of mature plants? Are they deep or shallow feeders? Germinate some oats or beans in a moist chamber as suggested and observe the root hairs.

SECTION IX — HOW A PLANT FEEDS FROM THE SOIL

Plants receive their nourishment from two sources,—from the air and from the soil. The soil food, or mineral food, must, dissolved in water, reach the plant through the root hairs, with which all plants are provided in great numbers. Each of these hairs may be compared to a finger reaching among the particles of earth for food and water. If we examine the root hairs ever so closely, we find no holes, or pores, in them. It is evident that no solid particles can enter the root hairs. All food must then pass into the root in solution.

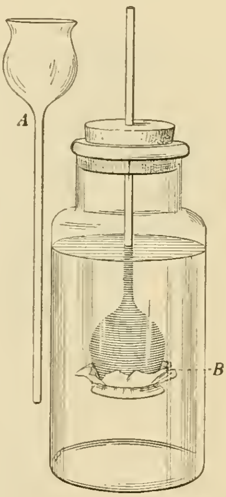


Fig. 22. Experiment to show how Roots take up Food

An experiment just here will help us to understand how a root feeds. Secure a narrow glass tube like the one in Fig. 22. If you cannot get a tube, a narrow, straight lamp chimney will, with a little care, do nearly as well. Cut from a bladder made soft by soaking, a piece large enough to cover the end of the tube or chimney and to hang over a little all around. Make the piece of bladder secure to the end of the tube by wrapping tightly with a waxed thread, as at *B*. Partly fill the tube with

molasses (or it may be easier in case you use a narrow tube to fill it before attaching the bladder). Put the tube into a jar or bottle of water so placed that the level of the molasses inside and the water outside will be the same. Fasten the tube in this position, and observe it frequently for three or four hours. At the end of the time you should find that the molasses in the tube has risen above the level of the liquid outside. It may even overflow at the top. If you use the lamp chimney, the rise will not be so clearly seen, since a greater volume is required to fill the space in the chimney. This increase in the contents of the tube is due to the entrance of water from the outside. The water has passed through the thin bladder, or membrane, and has come to occupy space in the tube. There is also a passage the other way, but the molasses can pass through the bladder membrane so slowly that the passage is scarcely noticeable. There are no holes, or pores, in the membrane, but still there is a free passage of liquids in both directions, although the more heavily laden solution must move more slowly.

A root hair acts in much the same way as the tube in our experiment, with the exception that it is so made as to allow certain substances to pass in only one direction, that is, toward the inside. The outside of the root hair is bathed in solutions rich in nourishment. The nourishment passes from the outside to the inside through the delicate membrane of the root hair. Thus does food enter the plant root. From the root hairs, foods are carried to the inside of the root.

From this you can see how important it is for a plant to have fine loose soil for its root hairs; also how necessary is the water in the soil, since the food can be used only when it is dissolved in water.

This passage of liquids from one side of a membrane to another is called *osmosis*, and has many uses in the plant kingdom. We say a root takes nourishment by osmosis.

SECTION X — ROOT TUBERCLES

Tubercle is a big word, but you ought to know how to pronounce it and what is meant by root tubercles.

We are going to tell you what a root tubercle is and something about its importance to agriculture. When you have learned this, we are sure you will want to examine some plants for yourself in order that you may see just what tubercles look like on a real root.

Fig. 23. Tubercles on the Roots of a Cowpea

Root tubercles do not form on all plants that farmers grow. They are formed only on those kinds that botanists call *legumes*. The clovers, cowpeas, vetches, and alfalfa are all legumes. The tubercles are little knotty, wartlike growths on the roots of the plants just named. These tubercles are caused by bacteria, or *germs*, as they are sometimes called.

Instead of living in nests in trees like birds or in the ground like moles and worms, these tiny germs, less than one twenty-five thousandth of an inch long, make their homes on the roots of these plants. Nestling snugly together, they live, grow, and multiply in their sunless homes. Through their activity the soil is enriched by the addition of much nitrogen from the air. They are the good fairies of the farmer, and no magician's wand ever blessed a land as much as these invisible folk bless the land that they live in.

Fig. 24. Soja Beans and Cowpeas. Two Great Soil Improvers

Just as bees gather honey from the flowers, and carry it to the hives where they prepare it for their own future use and for the use of others, so do these root tubercles gather nitrogen from the air and fix it in their root homes, where it can be used by other crops.

You were told something in the earlier pages of this book about the food of plants. One of the main elements of plant food, perhaps you remember, is nitrogen. Just as soon as the roots of the leguminous plants begin to push down into the soil, the bacteria, or germs that make the tubercles, begin to build their homes on the roots, and

in so doing they add nitrogen to the soil. You now see the importance of growing such crops as peas and clover on your land, for by their active aid you can constantly add plant food to the soil. Now this much needed nitrogen is the most costly part of the fertilizers that farmers buy every year. If every farmer, then, would grow these tubercle-bearing crops, he would rapidly add to the richness of his land and at the same time he would also escape the necessity of buying so much expensive fertilizer.

EXPERIMENT

Take a spade or shovel and dig carefully around the roots of a cowpea and a clover plant; loosen the earth thoroughly and then pull them up, being careful not to break off any of the roots. Now wash the roots, and after they become dry count the nodules, or tubercles, on the roots. Observe the difference in size. How are they arranged? Do all leguminous plants have equal numbers of nodules? How do these nodules help the farmer?

SECTION XI — THE ROTATION OF CROPS

I am sure you know what is meant by rotation, for your teacher has explained to you already how the earth rotates, or turns, on its axis and revolves around the sun. When we speak of crop rotation, we mean not only that the same crop should not be planted on the same land for two successive years but that crops should follow one another in a regular order.

Many farmers do not follow a system of farming that involves a change of crops. In some parts of the country the same fields are put to corn or wheat or cotton year

after year. This is not a good practice and sooner or later will wear out the soil completely, because the soil elements that furnish the food of that constant crop are soon exhausted and good crop production is no longer possible.

Why is crop rotation so necessary? There are different kinds of plant food in the soil. If any one of these is used up, the soil of course loses its power to feed plants properly.

FIG. 25. GRASS FOLLOWING CORN

Now each crop uses more of some of these different kinds of foods than others do, just as you like some kinds of food better than others. The crop, however, cannot, as you can, learn to use the kinds of food it does not like: it must use the kind that nature fitted it to use. Not only do different crops feed upon different soil foods, but they use different quantities of these foods.

Now if a farmer plant the same crop in the same field each year, that crop soon uses up all of the available plant food that it likes. Hence the soil can no longer properly nourish the crop that has been year by year robbing it. If that crop is to be successfully grown again upon the land, the exhausted element must be restored.

This can be done in two ways: first, by finding out what element has been exhausted and then by restoring this element either by means of commercial fertilizers or manure; second, by planting on the land crops that feed on different food and that will allow or assist kind Mother Nature "to repair her waste places." An illustration may help you to remember this fact. An element called nitrogen is one of the commonest plant foods. Nitrogen may almost be called plant bread. The wheat crop uses up a good deal of nitrogen. Suppose a field were planted in wheat year after year. Most of the available nitrogen would be taken out of the soil after a while, and a new wheat crop, if planted on the field, would not get enough of its proper food to yield a paying harvest. This same land, however, that could not grow wheat could produce other crops that do not require so much nitrogen. For example, it could grow cowpeas. Cowpeas, aided by their root tubercles, are able to gather a great part of the nitrogen needed for their growth from the air. Thus a good crop of peas can be obtained even if there is little available nitrogen in the soil. On the other hand, wheat and corn and cotton cannot utilize the free nitrogen of the air, and they suffer if there is an insufficient quantity present in the soil. Hence the necessity of growing legumes to supply the deficiency.

Let us now see how easily plant food may be economized by the rotation of crops.

If you sow wheat in the autumn, it is ready to be harvested in June, the very month for planting cowpeas. Plow the wheat stubble under, and sow the same field to cowpeas.

FIG. 26. COWPEAS AND CORN — AUGUST

By courtesy of Director B. W. Kilgore, from a forthcoming Bulletin

If the wheat crop has exhausted the greater part of the nitrogen of the soil, it makes no difference; for the cowpea will get its nitrogen from the air, and not only provide for its own growth, but, in the queer nodules of its roots, will leave quantities of nitrogen for the crops coming after it in the rotation.

If cotton be planted, there should be a rotation in just the same way. The cotton plant, a summer grower, of course uses a certain portion of the plant food stored in the soil. In order that it may feed on what the cotton did not use, the crop following cotton should be one that requires a somewhat different food. Moreover, it should

FIG. 27. COWPEAS AND CORN — OCTOBER

By courtesy of Director B. W. Kilgore, from a forthcoming Bulletin

be one that fits in well with cotton so as to make a winter crop. We find just such a plant in clover. Like the cowpea, all the different varieties of clover have on their roots tubercles that add the important element, nitrogen, to the soil.

From these facts is it not safe to conclude that if you wish to improve your land quickly and keep it always fruitful you must practice crop rotation?

An Illustration of Crop Rotation

Here is a system of rotation of crops as practiced at the North Carolina Agricultural and Mechanical College. It furnishes an ideal system of land preservation:

First Year		Second Year		Third Year	
Summer	Winter	Summer	Winter	Summer	Winter
Corn	Crimson clover	Cotton	Wheat	Cowpeas	Rye for pasture

If you analyze this rotation, you will find two nitrogen crops (cowpeas and crimson clover) for soil improvement and hay; two grain and fiber crops (wheat and cotton) for money crops; two cultivated crops (corn and cotton) for physical improvement of the soil and to kill weeds; and two live-stock crops (corn, and rye pasture) for pasture and ensilage.

EXERCISE

Let the pupils each present a system of rotation that includes the crops raised at home. The system presented should as nearly as possible meet the following requirements:

1. Legumes for gathering nitrogen.
2. Money crops for cash income.
3. Cultivated crops for tillage and weed destruction.
4. Food crops for feeding live stock.

CHAPTER III

THE PLANT

SECTION XII — HOW A PLANT FEEDS FROM THE AIR

If you partly burn a match, you will see that it becomes black. This black substance is called *carbon*. Examine a fresh stick of charcoal and estimate how much of a plant is carbon. You see in the charcoal every fiber that you saw in the wood itself. This means that every part of the plant contains carbon. How important, then, is this substance to the plant!

You will be surprised to know that all of the carbon in plants comes from the air. All the carbon that a plant gets is taken in by the leaves of the plant. Not a particle is taken by the roots.

A large tree, weighing perhaps 11,000 pounds, requires in its growth carbon from 16,000,000 cubic yards of air.

Perhaps, after these statements, you may think there is danger that the carbon of the air may sometime become exhausted. The air of the whole world contains about 1,760,000,000,000 pounds of carbon. Moreover, this is continually being added to by our fires and by the breath of animals. When wood or coal is used for fuel, the carbon of the burning substance is returned to the air in the form of gas. Some large factories burn great quantities of coal, and thus turn much carbon back to the air.

A single factory in Germany is estimated to give back to the air daily about 5,280,000 pounds of carbon. You see that the air is thus being replenished to make up for the carbon taken by the growing plants.

The carbon of the air can be used by none but green plants, and by them only in the sunlight. We may compare the green coloring matter of the leaf to a machine, and the sunlight to the power, or energy, which keeps the machine in motion. By means, then, of sunlight and the green coloring matter of the leaves, the plant secures carbon. The carbon passes into the plant and is there made into two foods very necessary to the plant, namely, starch and sugar.

Sometimes the plant uses the starch and sugar immediately. At other times it stores both away, as in the Irish and the sweet potato, beets, cabbage, peas, and beans. These plants are used as food by man because they contain so much nourishment, that is, starch and sugar that was stored away by the plant for its own future use.

EXERCISE

Examine some charcoal. Can you see the rings of growth? Slightly char paper, cloth, meat, sugar, starch, etc. What does the turning black prove? What per cent of these substances do you think is pure carbon?

SECTION XIII — THE SAP CURRENT

The root hairs take nourishment from the soil. The leaves manufacture starch and sugar. These manufactured foods must be carried to all parts of the plant. There are two currents to carry them. One passes from the roots

through the young wood to the leaves, and one, a downward current, passes through the bark, carrying needed food to the roots (see Fig. 28).

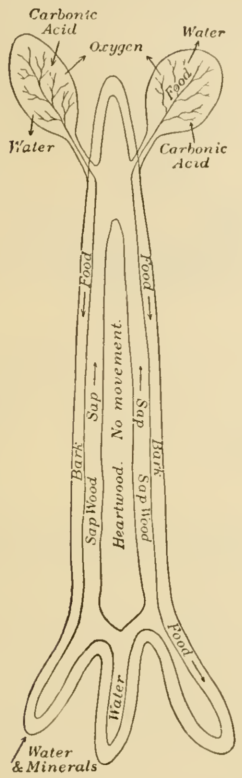


Fig. 28. Movement of the Sap Current

If you should injure the roots, the water supply to the leaves would be cut off and the leaves immediately wither. On the other hand, if you remove the bark, that is, girdle the tree, you in no way interfere with the water supply and the leaves do not wither. Girdling does, however, interfere with the downward food current through the bark.

If the tree be girdled, the roots sooner or later suffer from lack of food supply from the leaves. Owing to this food stoppage, the roots will cease to grow, and will soon be unable to take in sufficient water, and then the leaves will begin to droop. This, however, may not happen until several months after the girdling. Sometimes a partly girdled branch grows much in thickness just above the girdle, as in Fig. 29. This extra growth seems to be due to a stoppage of the rich supply of food which was on its way to the roots through

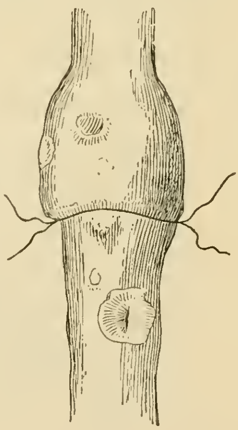


Fig. 29. A Thickening above the Wire that caused the Girdling

the bark. It could go no farther, and was therefore used by the tree to make at this point an unnatural growth.

It is, then, the general law of sap movement that the upward current from the roots passes through the woody portion of the trunk, and that the current bearing the food made by the leaves passes downward through the bark.

EXERCISE

Let the teacher see that these and all other experiments are performed by the pupils. Do not allow them to guess, but make them see.

Girdle valueless trees or saplings of several kinds, cutting the bark away in a complete circle around the tree. Do not cut into the wood. How long before the tree shows signs of injury? Girdle a single small limb on a tree. What happens? Explain.

SECTION XIV — THE FLOWER AND THE SEED

Some people think that the flowers by the wayside are for the purpose of beautifying the world and increasing man's enjoyment. Do you think this is true? Undoubtedly the flower is beautiful, and to be beautiful is one of the uses of many flowers; but that is not the chief use of a flower.

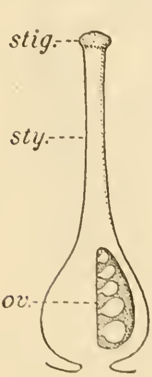


FIG. 30. PARTS OF THE PISTIL

You know that when peach or apple blossoms are nipped by the spring frost the fruit crop is in danger. The fruit of the plant bears the seed, and the flower produces the fruit. That is its chief duty.

Do you know any plant that produces seed without flowers? Some one answers, "The corn, the elm, and maple all produce seed, but have no flower." No,

that is not correct. If you look closely you will find in the spring very small flowers on the elm and on the maple, while the ear and the tassel are really the blossoms of the corn

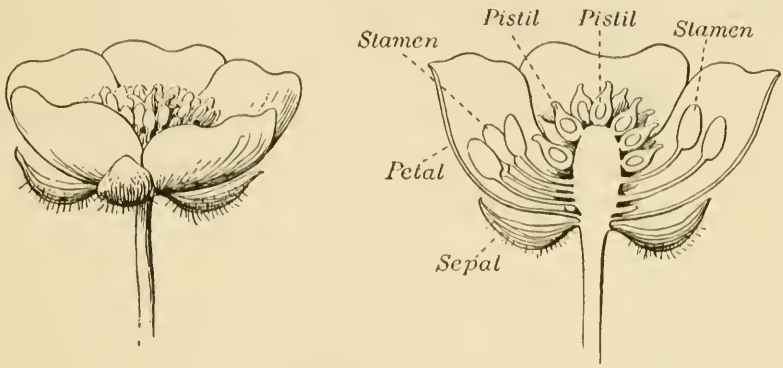


FIG. 31. A BUTTERCUP

plant. Although they may sometimes seem very curious flowers, yet every plant that produces seed has flowers.

Let us see what a flower really is. Take, for example, a buttercup, cotton, tobacco, or plum blossom (see Figs. 31 and 32). You will find on the outside a row of green leaves inclosing the flower when it is still a bud. These leaves are the *sepals*. Next on the inside is a row of colored leaves, or *petals*. Arranged inside of the petals are some

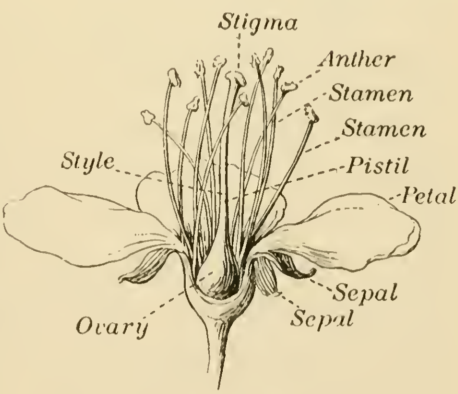


FIG. 32. A PLUM BLOSSOM

threadlike parts, each with a knob on the end. These are the *stamens*. Examine one stamen closely (Fig. 33). On the knob at its tip you should find, if the flower is fully open,

some fine grains, or powder. In the lily, this powder is so abundant that in smelling the flower you often brush a quantity of it off on your nose. This substance is called *pollen*, and the knob on the end of the stamen in which the pollen is borne is the *anther*.

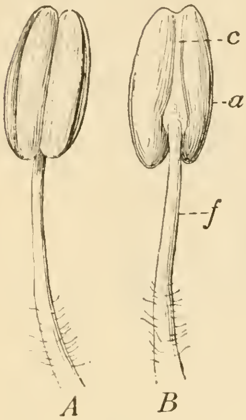


FIG. 33. STAMENS
a, anther; *f*, filament.

The pollen is of very great importance to the flower. Without it there could be no seeds. The stamens as pollen bearers, then, are very important. But there is another part to each flower that is of equal value. This part you will find in the center of the flower, inside the circle of stamens. It is called the *pistil* (Fig. 32). The swollen tip of the pistil is the *stigma*. The swollen base of the pistil forms the *ovary*. If you carefully cut open this ovary, you will find in it very small immature seeds.

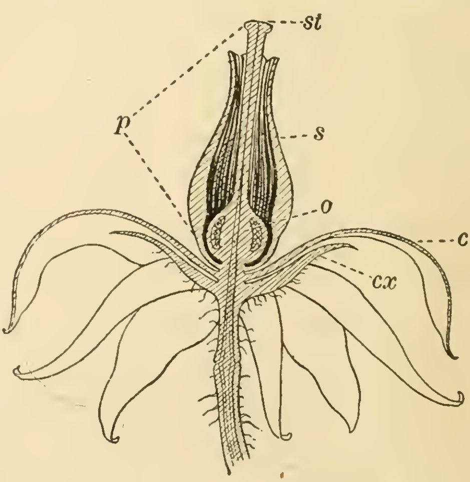


FIG. 34. TOMATO BLOSSOM

Some plants bear all these parts in the same flower; that is, each blossom has stamens, pistil, petals, and sepals. The pear and tomato blossoms represent such flowers. Other plants bear their stamens and pistils in separate blossoms. Stamens and pistils may even occur in separate plants, and some blossoms have no sepals or

petals at all. Look at the corn plant. Here the tassel is a cluster of many flowers, each of which bears only stamens. The ear is likewise a cluster of many flowers, each of which bears only a pistil. The dust that you see falling from the tassel is the pollen, and the long silky threads of the ear are the stigmas.

Now no plant can bear seeds unless the pollen of the stamen fall upon the stigma. Corn cannot therefore make seed unless the dust of the tassel fall upon the silk. Did you ever notice how poorly the cob is filled on a single corn stalk standing alone in the field? Do you see why? It is because that, when a plant stands alone, the wind blows the pollen away from the tassel, and little or none is received on the stigmas below.

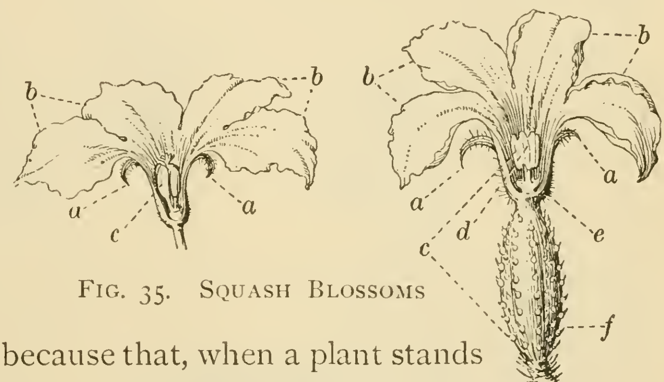


Fig. 35. Squash Blossoms

In the corn plant the stamens and pistils are separate; that is, they do not occur on the same flower although they are upon the same plant. This is also true of the squash (see Fig. 35). In many plants, however, as the hemp, hop, sassafras, willow, and others, the staminate parts are on one plant and the pistillate parts are on another. This is also true in several other cultivated plants. For example, in some strawberries the stamens are absent or useless; that is, they bear no good pollen. In such cases the grower must see to it that near by are strawberry plants that bear stamens in order that these plants which do not

bear pollen may become *pollinated*, that is may have pollen carried to them. After the stigma has been supplied with pollen, a single pollen grain sends a threadlike sprout down through the stigma into the ovary. This process if successfully completed is called *fertilization*.

EXERCISE

Examine several flowers and identify the parts named in the last chapter. Try in proper season to find the pollen in the maple, willow, alder, and pine, wheat, cotton, and morning-glory.

How fast does the ovary of the apple blossom enlarge? Measure one and watch it closely from day to day. Can you find any plants that have their stamens and ovaries on separate individuals?

SECTION XV — POLLINATION

Nature uses several interesting ways to secure pollen transportation. In the corn, willow, and pine, the pollen is picked up by the wind and carried away. Much of it is lost, but some reaches the stigmas or receptive parts of other corn, willow, or pine flowers. This is a very wasteful method, and all plants using it must provide much pollen.

Many plants employ a much better method. They have learned how to make insects bear their pollen. In plants of this type, the parts of the blossom are so shaped and so placed as to deposit pollen from the stamen on the insect and to receive pollen from the insect upon the stigmas.

When you see the clumsy bumblebee clambering over and pushing his way into a clover blossom, you may be sure that he is getting well dusted with pollen and that the next blossom he visits will secure a full share on its stigma.

When flowers fit themselves to insect pollination, they can no longer use the wind, and are helpless if insects do not visit them. They therefore cunningly resort to two chief means to make sure of the visits of insects. First, they provide a sweet nectar as a repast for the insect visitor. The nectar is a sugary solution found in the bottom of the flower and is used by the visitor as food or to

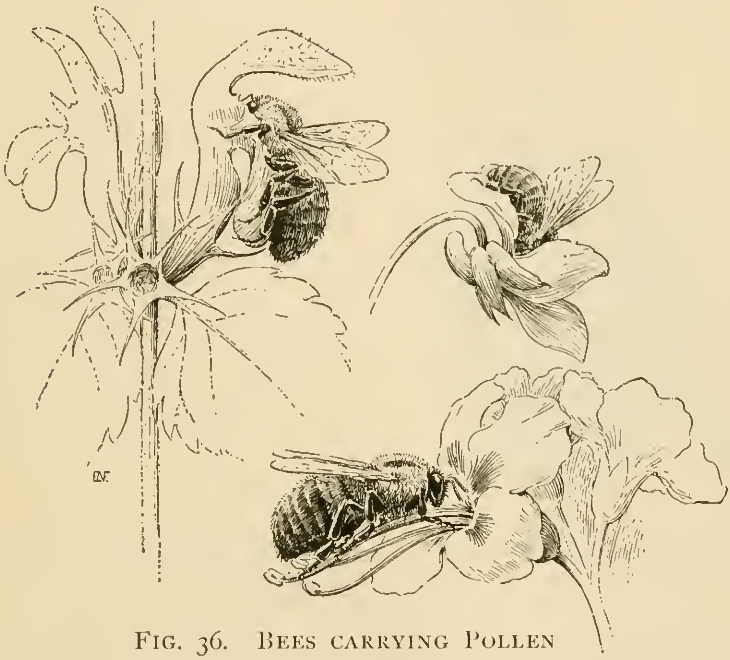


FIG. 36. BEES CARRYING POLLEN

make honey. Second, flowers advertise to let the insect world know that they have something for it. The advertising is done by means either of showy colors or of fragrant perfume. Insects have wonderful powers of smell. You may hereafter know that showy or fragrant flowers are advertising the presence either of nectar or pollen (to make beebread) and that they are also dependent upon insects for pollination.

A season of heavy, cold rains during blossoming time may often injure the fruit crop by preventing timely visits from insects. You now also understand why plants often refuse to produce seeds indoors. They cannot, since they are shut in, receive proper insect visits. Plants such as tomatoes or other garden fruits dependent upon insect pollination must, if raised in the greenhouse, be pollinated by hand.

EXERCISE

Exclude insect visitors from some flower or flower cluster, e.g. clover, by covering with a paper bag, and see if they can produce seeds that are capable of growing. Compare, as to number and vitality, the seeds of such a flower with those of an uncovered flower. Observe insects closely. Do you ever find pollen on them? What kinds of insects visit the clover? the cowpea? the sourwood? the flax? Is wheat pollinated by insects or by wind or by some other means? Do bees fly in rainy weather? How will a long rainy season at blossoming time affect the apple crop? Why? Should bees be kept in an orchard? Why?

SECTION XVI — CROSSES, HYBRIDS, AND CROSS POLLINATION

In our study of flowers and their pollination we have seen that the seed is usually the descendant of two parents or at least of two organs: one the ovary, producing the seed, the other the pollen, which is necessary to fertilize the ovary.

It happens that sometimes the pollen of one blossom fertilizes the ovary of its own flower, but more often the pollen from one plant fertilizes the ovary of another plant. This latter method is called *cross pollination*. As a rule, cross pollination produces a stronger seed, that is, a seed

that will produce a better plant. Cross pollination by hand is often used by plant breeders when, for purposes of seed selection, a specially strong plant is desired. The steps in hand pollination are as follows: (1) remove the anthers before they open to prevent them from pollinating the stigma (the steps in this process are illustrated in Figs. 37, 38, and 39); (2) cover the flower thus treated with a paper bag to prevent access of stray pollen (see Fig. 40); (3) when the ovary is sufficiently developed, carry pollen to the stigma by hand from the anthers of another plant which you have selected to furnish it, and rebag to prevent access of any stray pollen which might accidentally get in; (4) collect seed when mature and label properly.

FIG. 37

The bud on right at top is in proper condition for removal of anthers; the anthers have been removed from the buds below

Hand pollination has this advantage, — you know both parents of your seed. If pollination occur naturally, you know the maternal but have no means of judging the paternal parent. You can readily see, therefore, how hand pollination enables you to secure seed derived from two well-behaved parents.

Sometimes we can breed one kind of plant upon another. The result of such cross breeding is known as a *hybrid*. In

the animal kingdom we have in the mule a common example of this cross breeding. Plant hybrids were formerly called mules also, but this suggestive term is now about out of use.

It is only when plants of two distinct kinds are crossed

FIG. 38. ORANGE BLOSSOM PREPARED FOR CROSSING

First, bud; second, anthers unremoved; third, anthers removed

that the result is called a hybrid; for example, a blackjack oak on a white oak, an apple on a pear. If the parent plants are more closely related, as, for example, an apple of

FIG. 39. TOMATO BLOSSOM READY TO CROSS

First, bud; second, anthers unremoved; third, anthers removed

one kind with another variety of apple, the result is known simply as a *cross*.

Hybrids and crosses are valuable in that they usually differ from both parents yet combine some of the qualities

of each, emphasizing some, omitting others. They thus often produce an interesting new kind of plant. Sometimes we are able by hybridization to combine in one plant the good qualities of two other plants, and thus make a great advance in agriculture. The new forms brought about by hybridization may be fixed or made permanent by such

FIG. 40

First, blossom bagged to prevent access of stray pollen ; second, fruit bagged for protection

selection as is mentioned in Section XVIII. Hybridization is of great aid in originating new plants.

It often happens that a plant will be more fruitful when pollinated by one variety than by some other variety. This is well illustrated in the accompanying figure (Fig. 41). A fruit grower or farmer should know much about these subjects before selecting varieties for his orchard, vineyard, etc.

EXERCISE

Consult Bulletin 29, Vegetable Physiology and Pathology, Department of Agriculture.

Read Bailey's "Plant Breeding," and then attempt to cross some plants. You must remember that many crosses must be attempted in order to gain success with even a few.

SECTION XVII — PLANT PROPAGATION BY BUDS

It is the business of the farmer to propagate plants. This he does in one of two ways: by buds, that is by small pieces cut from parent plants, or by seeds. The chief aim in both methods should be to secure in the most convenient manner the best paying plants.

Many plants are most easily and quickly propagated by buds, as for example the grape, red raspberry, fig, and many others that we cultivate for the flower only, such as the carnation, geranium, rose, and begonia.

In growing plants from cuttings, a piece is taken from the kind of plant that one wishes to grow. The greatest care must be exercised in order to get a healthy cutting. If we take a cutting from a poor plant, what can we expect but to grow a poor plant like the one from which our cutting was taken? On the other hand, if a fine, strong, vigorous, fruitful plant be selected, we shall expect to produce just such a fine, strong, fruitful plant.

We expect the cutting to make just exactly the same variety of plant as the parent stock. We must therefore decide upon the variety of berry, grape, fig, carnation, or rose that we wish to propagate, and then look for the strongest and most promising plants of this variety at our

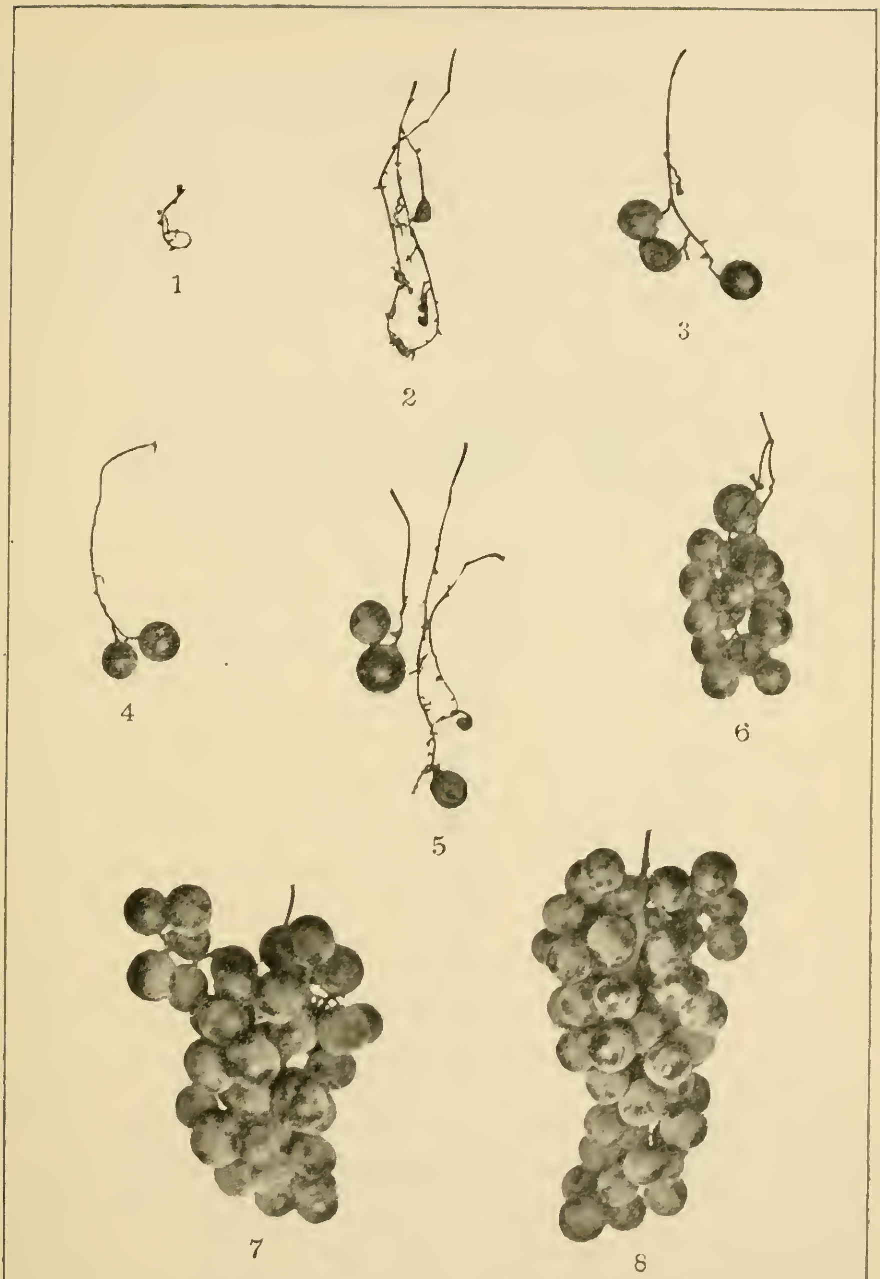


Fig. 41

Brighton pollinated by (1) Salem, (2) Creveling, (3) Lindley, (4) Brighton, (5) Self-pollinated, (6) Nectar, (7) Jefferson, (8) Niagara

disposal. The utmost care will not produce a fine plant if we start from poor stock.

What qualities are most desirable in a plant from which cuttings are to be taken? First, it should be productive, hardy, and fit for your climate and your needs; second, it should be healthy. Do not take cuttings from a diseased

FIG. 42. GERANIUM CUTTING

Showing depth to which cutting should be planted

plant, since the cutting may carry the disease, as it often does in the case of the chrysanthemum and carnation.

Cuttings may be taken from various parts of the plant, sometimes even from parts of the leaf, as in the begonia (Fig. 46). More often, however, they are drawn from parts of the stem (Figs. 43, 44, 45). As to the age of the twig from which the cutting is to be taken, Professor Bailey

says: "For most plants the proper age or maturity of wood for the making of cuttings may be determined by giving the twig a quick bend; if it snaps and hangs by the bark, it is in proper condition. If it bends without breaking, it is too young and soft or too old. If it splinters, it is too old and woody." Some plants, as the geranium, succeed better if the cuttings from which they are grown are taken from soft, young parts of the plant; others, for example, the grape or rose, do better when the cutting is made from more mature wood.

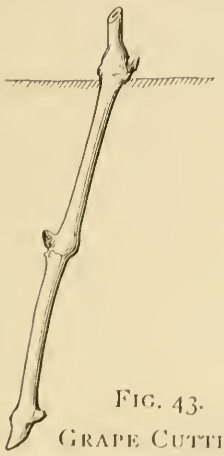


Fig. 43. Grape Cutting

Showing depth to which cutting should be planted

Cuttings may vary in size, and may include one or more buds. After a hardy, vigorous cutting is made, insert it about one half or one third of its length in soil. A soil free from organic matter is much the best, since in such soil cuttings are much less liable to disease. A fine, clean sand is commonly used by professional gardeners. When cuttings have rooted well, — this may require a month or more, — they may be transplanted to larger pots.

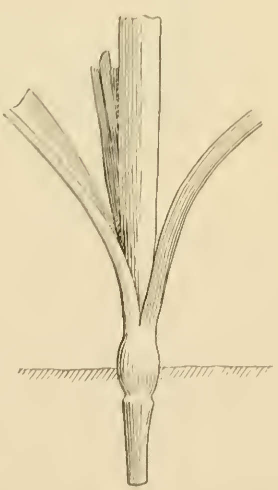


Fig. 44. Carnation Cutting

Sometimes, instead of cutting off a piece and rooting that, portions of branches are made to root before they

are separated from the parent plant. This method is often followed and is known as *layering*. It is a simple process. Just bend the tip of a bough down and bury it in the earth (see Fig. 47). The raspberry and blackberry form layers naturally, but man often aids them by burying the overhanging tips in the earth, so that more tips may readily root. The strawberry develops runners that root themselves in a similar fashion.

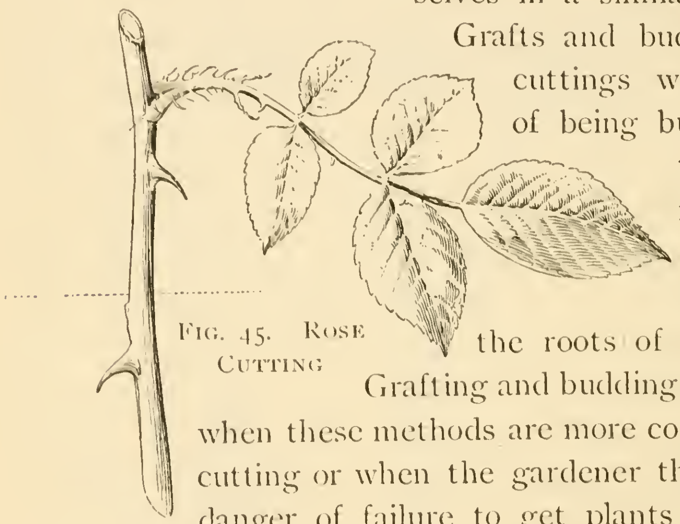


FIG. 45. ROSE CUTTING

Grafts and buds are really cuttings which, instead of being buried in sand to produce roots of their own, are placed upon the roots of other plants. Grafting and budding are practiced when these methods are more convenient than cutting or when the gardener thinks there is danger of failure to get plants to take root as cuttings. Neither grafting nor budding is, however, necessary for the raspberry or the grape, for these propagate most readily from cuttings.

It is often the case that a budded or grafted plant is more fruitful than a plant upon its own roots. In cases of this kind, of course, grafts or buds are used.

The white, or Irish, potato is usually propagated from pieces of the potato itself. Each piece used for planting bears one eye or more. The potato itself is really an underground stem and the eyes are buds. This method of propagation is therefore really a peculiar kind of cutting.

Since the eye is a bud and our potato plant for next year is to develop from this bud, it is of much importance, as we have seen, to know exactly what *kind* of plant our potato comes from. If our potato is taken from a small plant that had but a few poor potatoes in the hill, we may expect the bud to produce a similar plant next year and a correspondingly poor crop. We must see to it, then, that our seed potatoes come from vines that were good producers, because new potato plants are like the plants from which they were grown. Of course we cannot tell when our potatoes are in the bin from what kind of plants they came. We must therefore *select our seed potatoes in the field.* Seed potatoes should always be selected from those hills that produce most bountifully. Be assured that the increased yield will richly repay this care. It matters not so much whether the seed potato be large or small; it must, however, come from a hill bearing a large yield of fine potatoes.

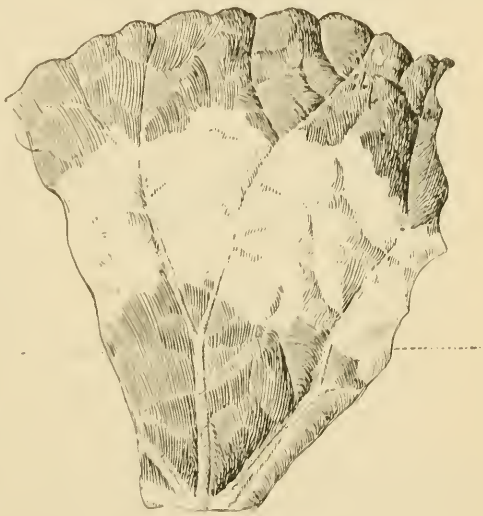


FIG. 46. BEGONIA LEAF CUTTING

Sweet potato plants are produced from shoots, or growing buds, taken from the potato itself, so that in their case too the piece that we use in propagating is a part of the original plant, and will therefore be like it under similar conditions. Just as with the Irish potato, it is

important to know how good a yielder you are planting. You should watch during harvest and select for propagation for the next year only such plants as yield best.

We should exercise fully as much care in selecting proper individuals from which to make a cutting or a layer as we do in selecting a proper individual of live stock to breed from. Just as we select the finest Jersey in the herd for breeding purposes, so we should choose first the variety of plant we desire, and then the finest individual plant of that variety.

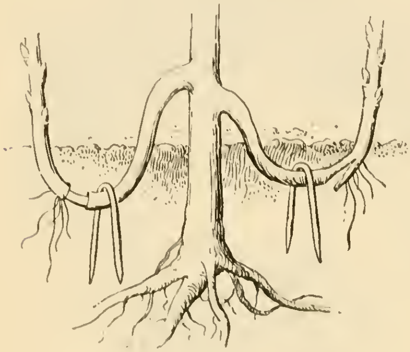


FIG. 47. LAYERING

If the variety of the potato that we desire to raise be Early Rose, it is not enough to select *any* Early Rose plants, but the very best Early Rose plants to furnish our seed.

It is not enough to select large, fine potatoes for cuttings. A large potato may not produce a bountifully yielding plant. *It will produce a plant like the one that produced it.* It may be that this one large potato was the only one produced by the original plant. If so, the plant that grows from it will tend to be similarly unproductive. Thus you see the importance *of selecting in the field a plant that has exactly the qualities desired in the new plant.*

One of the main reasons why gardeners raise plants from buds instead of from seeds is that the seed of many plants will not produce plants like the parent. This failure "to come true," as it is called, is sometimes of value, for it occasionally leads to improvement. For example, suppose

that a thousand apple or other fruit or flower seeds from plants usually propagated by cuttings be planted; it may be that one out of a thousand or a million will be a very valuable plant. If a valuable plant be so produced, it should be most carefully guarded, multiplied by cuttings or grafts, and introduced far and wide. It is in this way that new varieties of fruits and flowers are produced.

FIG. 48. CURRANT CUTTING

Sometimes, too, a single bud on a tree will differ from other buds and will produce a branch different from other branches. This is known as *bud variation.* When there is thus developed a branch which happens to be of superior kind, it should be propagated by cuttings just as you would propagate it if it had originated from a seed.

Mr. Gideon of Minnesota planted many apple seeds, and from them all raised one tree that was very fruitful, finely flavored, and able to withstand the cold Minnesota winter. This tree he multiplied by grafts and named the Wealthy apple. It is said that in giving this one apple to the world he benefited the world to the value of more than one million dollars. You must not let any valuable bud or seed variant be lost.

PLANTS TO BE PROPAGATED FROM BUDS

The following list gives the names and methods by which our common garden fruits and flowers are propagated:

Figs: use cuttings 8 to 10 inches long or layer.

Grapes: use long cuttings, layer, or graft upon old vines.

Apples: graft upon seedlings, usually crab seedlings one year old.

Pears: bud upon pear seedlings.

Cherries: bud upon cherry stock.

Plums: bud upon peach stock.

Peaches: bud upon peach or plum seedlings.

Quinces: use cuttings or layering.

Blackberries: layer; remove old stem after fruiting.

Raspberries: layer; remove old stem.

Red raspberries: propagate by root cuttings.

Strawberries: propagate by runners.

Currants and *gooseberries:* use long cuttings (these plants grow well only in cool climates. If attempted in warm climates, set in cold exposure).

Carnations, geraniums, roses, begonias, etc.: propagate by cuttings rooted in sand and then transplanted to small pots.

EXERCISE

Propagate fruits (grape, fig, strawberry) of various kinds; also ornamental plants. How long does it take them to root? Geraniums rooted in the spring will bloom in the fall. Do you know any one who selects "seed" potatoes properly? Try a careful selection of seed at next harvest time.

SECTION XVIII — PLANT SEEDING

In propagating by seed, as in reproducing by buds, we select a portion of the parent plant — for a seed is surely a part of the parent plant — and place it in the ground. There is, however, one great difference between a seed and a bud. The bud is really a piece of the parent plant,

but a piece of *one* plant only; while a seed comes from the parts of two plants.

You will understand this fully if you read carefully Sects. XIV, XV, and XVI. Since the seed is made of two plants, the plant that springs from a seed is much more likely to differ from its mother plant, that is, from the plant that produces the seed, than is a plant produced merely by buds. In some cases plants "come true to seed" very accurately. In others they vary greatly. For example, when we plant the seed of wheat, turnips, rye, onions, tomatoes, tobacco, or cotton, we get plants that are in most respects like the parent plant. On the other hand, the seed of a Crawford peach, or a Baldwin apple, or a Bartlett pear will not produce plants like its parent, but will rather resemble its wild ancestors of years ago. These seedlings, thus taking after their ancestors, are always far inferior to our present cultivated forms. In such cases seeding is not practicable, and we must resort to bud propagation of one sort or another.

While, in a few plants like those just mentioned, the seed does not "come true," most plants, as for example cotton, tobacco, and others, do "come true." When we plant King cotton, we may expect to raise King cotton. There will, however, be some or even considerable variation in the field, as every one knows. Some plants even in exactly the same soil will be better than the average, and some will be poorer. Now we see this variation in the plants of our field, and we believe that the plant will be in the main like its parent. What should we learn from this? Surely that if we wish to produce sturdy, healthy, productive plants we must go into our field and *pick out just such plants to*

FIGS. 49 AND 50. CHRYSANTHEMUM AND ASPARAGUS

secure seed from as we wish to produce another year. If we wait until the seed is separated from the plant that produced it before we select our cotton seed, we shall be planting seed from poor as well as good plants, and must be content with a crop of just such stock as we have planted. By selecting seed from the most productive plants *in the field*, and by repeating the selection each year, you can continually improve the breed of the plant you are raising. In applying this to cotton you may follow the plan suggested for wheat below.

FIG. 51. TWO VARIETIES OF FLAX FROM ONE PARENT STOCK

After original in "Year Book," United States Department of Agriculture

The difference that you see between the wild and cultivated chrysanthemums and the samples of asparagus shown in Figs. 49 and 50 was brought about by just such continuous seed selection.

By the careful selection of seed from the longest flax plants, the increase in length shown in the accompanying figure was attained. The selection of seed from those plants bearing the most seed, but regardless of the height of the plant, has produced flax like that to the right in the illustration. These two kinds of flax are from the same parent

stock, but slight differences have been emphasized by continued *seed selection*, until we now have really two varieties of flax, one a heavy seed bearer, the other producing a long fiber.

You can in a similar way improve your cotton or any other seed crop. Sugar beets have been made by seed selection to produce about double the percentage of sugar that they did a few years ago. It costs too much and is too laborious to prepare and to till land to allow it to be planted with poor seed. The following are the qualities of the parent plant that ought to be sought for in trying by seed selection to improve the yield of the cotton stalk: first, seed should be chosen only from plants that bear many well-filled bolls of long staple cotton; second, seed should be taken from no plant that does not by its healthy condition show hardihood in resisting disease and drought.

The plan of choosing seeds from selected plants may be applied to wheat; but it would be too time-consuming to select enough single wheat plants to furnish all of the seed wheat for next year. In this case adopt the following plan. In Fig. 52, let *A* represent the total size of your wheat field, and let *B* represent a plat large enough to furnish seed for the whole field. At harvest time go into section *A* and select the best plants you can find. Pick the heads of these and thresh them by hand. The seed so obtained must be carefully saved for your next sowing.

In the fall sow these selected seeds in area *B*. This area should produce the best wheat. At the next harvest cull not from the whole field but from the finest plants of plat *B*, and again save these as seed for plat *B*. Use the unculled seed from plat *B* to sow your crop. By following

this plan continuously you will have every year seed from several generations of choice plants, and will each year improve your seed.

It is of course advisable to move your seed plat *B* every year or two. Select for the new plat land that has recently been planted in legumes. Always give this plat unwearying care.

In this selection of plants from which to get seed, you must know what kind of plants are really the best seed plants.

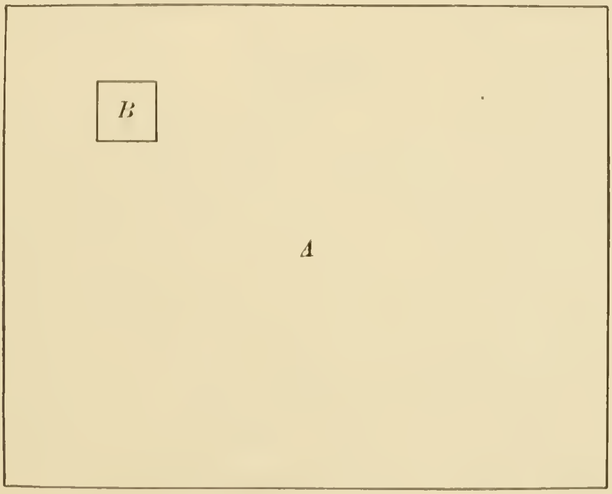


Fig. 52

First, *you must not regard single heads or grains, but must select seed from the most perfect plant*, looking at the plant as a whole and not at any single part of it. A first consideration is yield. Select the plants that yield best and are at the same time resistant to drouth, resistant to rust and to winter, early to ripen, plump of grain, and non-shattering. What a fine thing it would be to find even one plant free from rust in the midst of a rusted field! It would mean *a rust-resistant plant*. Its offspring would

probably be also rust resistant. If you should ever find such a plant, be sure to save its seed, and plant it in a plat by itself. The next year again save seed from those plants least rusted. Possibly you can develop a rust-proof race of wheat! Keep your eyes open.

In England the average yield of wheat is thirty bushels an acre, in the United States less than fifteen bushels! In some states the yield is even less than nine bushels an acre. Let us select our seed with care, as the English people do, and then we can increase our yield. By careful seed selection a plant breeder in Minnesota increased the yield of his wheat by one fourth. Think of what it would mean if twenty-five per cent were added to the world's supply of wheat at comparatively no cost, that is, the mere cost of careful seed selection. This would mean an addition to the world's income of about $500,000,000 each year. The United States would get about one fifth of this profit.

It often happens that a single plant in the crop of corn, cotton, or wheat will be far superior to all others in the field. Such a plant deserves special care. Do not use it merely as a seed plant, but carefully plant its seeds apart and tend carefully. The following season select the best of its offspring as favorites again. Repeat this selection and culture for several years until you fix the variety. This is the way new varieties are originated from plants propagated by seed.

In 1862, Mr. Abraham Fultz of Pennsylvania, while passing through a field of bearded wheat, found three heads of beardless, or bald, wheat. These he sowed by themselves that year, and, as they turned out specially productive, he continued to sow this new variety. Soon he had

enough seed to distribute over the country. It became known as the Fultz wheat, and is to-day one of the best varieties in the United States and in a number of foreign countries. Think how many bushels of wheat have been added to the world's annual supply by a few moments of intelligent observation and action on the part of this one man! He saw his opportunity and used it. How many similar opportunities do you think are lost? How much does your state or country lose thereby?

EXERCISE

Select one hundred seeds from a good and one hundred from a poor plant of the same variety. Sow them in two plats far enough apart to avoid cross pollination, yet try to have soil conditions about the same. Give each the same care and compare the yield. Try this with corn, cotton, wheat. Select seeds from the best plant in your good plat and from the poorest in your poor plat and repeat the experiment. This will require but a few feet of ground, and the good plat will pay for itself in yield and the poor plat will more than pay in the lesson that it will teach you.

Read page 68, Bulletin 24, of the Division of Vegetable Physiology and Pathology of the Department of Agriculture or the Year Book of the Department of Agriculture for 1896 (pages 489–498), which you can get by writing to the Department of Agriculture, Washington, D.C. Write to the Department of Agriculture for any bulletins that they can give you on plant breeding.

SECTION XIX — SELECTING SEED CORN

If a farmer would raise good crops, he must select good seed. Many of the farmer's disappointments in the quantity and quality of his crops, disappointments often attributed to other causes, are the result of planting poor seed.

Seeds not fully ripened, if they grow at all, produce imperfect plants. Good seeds, therefore, are the first things necessary for a good crop. The seed of only perfect plants should be saved.

By judicious and persistent selection, made in the field before the crop is fully matured, corn can be improved to an almost unlimited extent in size and early maturity. Gather only ears from the most productive plants, and save only the largest and most perfect kernels.

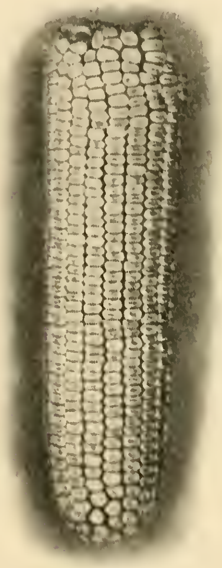


FIG. 53. THE KIND OF EAR TO SELECT

I am sure that you have seen the common American blackbirds that usually migrate and feed in such large numbers. They all look alike in every way. Now has it ever occurred to you to ask why all blackbirds are black? The blackbirds are black simply because their parents are black.

Now in the same way that the young blackbirds resemble their parents, corn will resemble its parent stock. How many ears of corn do you find on a stalk? One, two, sometimes three or four. You find two ears of corn on a stalk because it is the nature of that particular stalk to produce two ears. In the same way the nature of some stalks is to produce but one ear, while sometimes it is the nature of others to produce three.

This resemblance of offspring to parent is known to scientists as *heredity*, or as "like producing like."

We can take advantage of this law in improving our

corn crop. If a stalk can be made to produce two ears of corn just as large as the single ear that most stalks bear, we shall get just twice as much corn from a field in which the "two-eared" variety is planted.

This fact ought to be very helpful to us next year when our fathers are planting corn. We should get them to plant seed secured only from stalks that produced the most corn. If we follow this plan year by year, each acre of land will be made to produce more kernels and hence a larger crop of corn, and yet no more work will be required to raise the crop.

Fig. 54. Select Seed from Stalk on Left

In addition to enlarging the yield of corn, you can by proper selection of the best and most productive plants in the field grow a new variety of seed corn. To do this you need only take the largest and most perfect kernels from stalks bearing two ears; plant these, and at the next harvest again save the best kernels from stalks bearing two or more ears. If you keep up this practice with great care for several years, you will get a vigorous, fruitful variety that will command a high price for seed.

EXPERIMENT

Every school boy and girl can make this experiment at leisure. From your own field get two ears of corn, one from a stalk bearing only one ear and the other from a stalk bearing two well-grown ears.

Plant the grains from one ear in one plat, and the grains from the other in a plat of equal size. Use for both the same soil and the

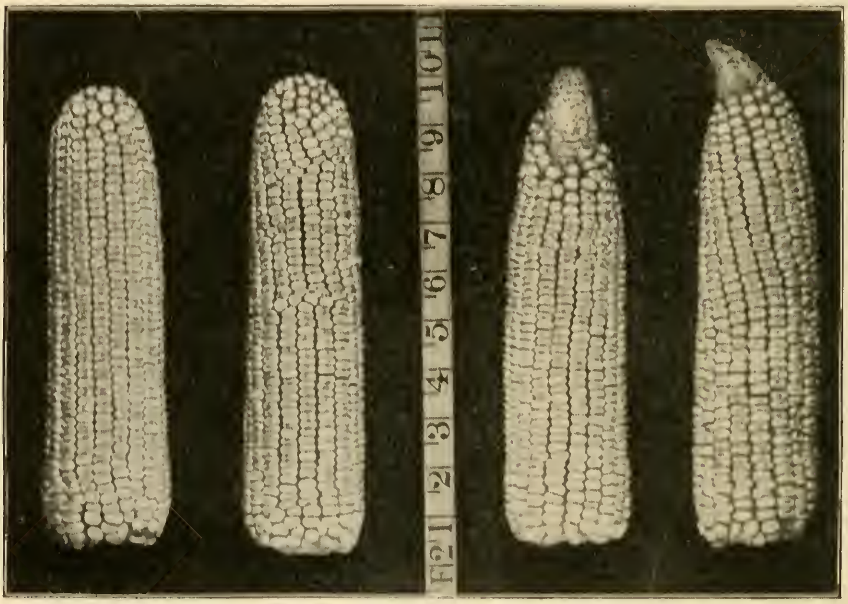


FIG. 55. IMPROVEMENT OF CORN BY SELECTION

Boone County white corn on left, and original type from which it was developed by selection on right. From original furnished by the United States Department of Agriculture

same fertilizer. Cultivate both plats in the same way. When the crop is ready to harvest, husk the corn, count the ears, and weigh the corn. Then write a short essay on the way you did the work and on your results. Get your teacher to read and correct your writing, and then send your essay to your home paper and to some agricultural paper.

SECTION XX — WEEDS

Have you ever noticed that some weeds are killed by one particular method, while this same method may entirely fail with other kinds of weeds? If we wish to free our fields of weeds with the greatest ease, we must know the nature of each kind of weed and then attack it in the way that we can most readily destroy it.

FIG. 56. PIGWEED

The ordinary pigweed (Fig. 56) differs from many other weeds in that it lives for only one year. When winter comes, it must die. Each plant, however, bears a great number of seeds. If we can prevent the plant from making seed in its first year, there will not be many seeds to come up the next season. In fact, only those seeds that were too deeply buried in the soil to come up the previous spring will be left, and of these two-year-old seeds many will not germinate. During the next season some old seeds will produce plants, but the number will be very much diminished. If care be exercised to prevent the pigweed from seeding again, and the same watchfulness be continued for a few seasons, the pigweed will be almost entirely driven from our fields.

A plant like the pigweed, which lives only one year, is called an *annual*, and is one of the easiest of weeds to destroy. Mustard, plantain, chess, dodder, cockle, crab grass, and Jimson weed are a few of our most disagreeable annual weeds.

Fig. 57. Wild Carrot

The very best time to kill any weed is when it is very small; therefore the ground in early spring should be constantly stirred in order to kill the young weeds before they grow to be strong and hardy.

The wild carrot differs from an annual, for it lives throughout one whole year without producing seeds. During its first year it accumulates a quantity of nourishment in the root, then rests over winter, and in the following summer it uses this nourishment rapidly in the production of flowers and seeds. Then the plant dies. Plants that live through two seasons in this way are called *biennials*. Weeds of this kind may be destroyed by *cutting the roots below the leaves* with a grubbing hoe or spud. A spud may be described as a chisel on a long

handle (see Fig. 58). If biennials are not cut low enough, they will branch out anew and make many seeds. The most common biennials are the thistle, moth mullein, wild carrot, wild parsnip, and burdock.

Fig. 58. A Spud

Fig. 59. Hound's Tongue

A third group of weeds consists of those that live for more than two years. These weeds are usually most difficult to kill. They propagate by means of running rootstocks as well as by seeds. Plants that live more than two seasons are known as *perennials* and include, for example, many grasses, dock, Canada thistle, poison ivy, passion flower, horse nettle, etc. There are many methods of

destroying perennial weeds. They may be dug entirely out and removed. Sometimes in small areas they may be killed by crude sulphuric acid or may be starved by covering them with boards or a straw stack or in some other convenient way. A method that is very effective is to smother the weeds by a dense growth of some other plant, for example, cowpeas or buckwheat. Cowpeas are to be preferred, since they also enrich the soil by the nitrogen that the root tubercles gather.

Fig. 60. Canada Thistle

Weeds do injury in numerous ways: they shade the crop, steal its nourishment, and waste its moisture. Perhaps their only service is to make lazy people till their crops.

EXERCISE

You should learn to know by name the twenty worst weeds of your vicinity and to recognize their seeds. If there are any weeds you are not able to recognize, send a sample to your State Experiment Station. Make a collection, properly labeled, of weeds and weed seeds for your school.

Procure from the Department of Agriculture Farmers' Bulletin 28 on "Weeds and How to Kill Them."

SECTION XXI — SEED PURITY AND VITALITY

Seeds produce plants. The difference between a large and a small yield may depend upon the kind of plants we raise, and the kind of plant in turn is dependent upon the seeds that we sow.

Two considerations are important in the selection of seeds, — namely, purity and vitality. Seeds should be *pure;* that is, when sown they should produce no other plant than the one that we wish to raise. They should be able to grow. The ability of a seed to grow is termed its *vitality*. Good seed should be nearly or quite pure and should possess high vitality. The vitality of seeds is expressed in per cent ; for example, if 97 seeds out of 100 germinate, or sprout, the vitality is said to be 97. The older the seed the less is its vitality, except in a few rare instances in which seeds cannot germinate under two or three years.

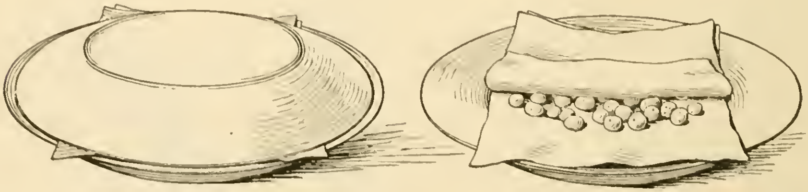
Cucumber seeds may show 90 per cent vitality when they are one year old ; 75 per cent when two years old, and 70 per cent when three years old, — the per cent of vitality diminishing with increase of years. The average length of life of seeds of cultivated plants is short : for example, the tomato lives four years ; corn, two years ; onion, two years ; radish, five years. The cucumber seed may retain life after ten years, though even with it, the older the seed the poorer.

It is important when buying seeds of dealers to test these two properties of seeds, — purity and vitality. Unscrupulous dealers often sell old seeds, although they know that seeds decrease in value with age. Sometimes, however, to

cloak dishonesty they mix some new seeds with the old, or bleach old and yellow seeds in order to make them resemble fresh, new seed.

It is important, therefore, that all seeds bought of dealers should be thoroughly examined and tested; for if seeds do not grow, we not only pay for that which is useless, but we are also in great danger of producing so few plants in our field that we shall not get full use of the land, and may thus suffer a more serious loss than merely paying for a few dead seeds.

To test the vitality of seeds, plant one hundred seeds in a pot of earth or in damp sand, or place between moist pieces of flannel, and take care to keep them moist and warm. Count those that germinate and thus determine the percentage of vitality. Germinating between flannel is much quicker than planting in earth. Care should be used to keep mice away from germinating seeds. (See Fig. 61.)



A *B*

FIG. 61. A SEED GERMINATOR

Consisting of two soup plates, some sand, and a piece of cloth

Sometimes the appearance of a package will indicate whether the seed has been kept in stock a long time. It is, however, much more difficult to find out whether the seeds are pure. You can of course easily distinguish seeds that differ much from the seeds you wish to plant, but often

certain weed seeds are so nearly like certain crop seeds that the weed seeds are not easily recognized by the eye. Thus, for example, the dodder or "love vine," which so often ruins the clover crop, has seeds closely resembling clover seeds. The chess, or cheat, has seeds so nearly like oats that only a close observer can tell them apart. However, if you watch the seeds that you buy and study the appearance of crop seeds, you may become very expert in recognizing seeds that have no place in your planting.

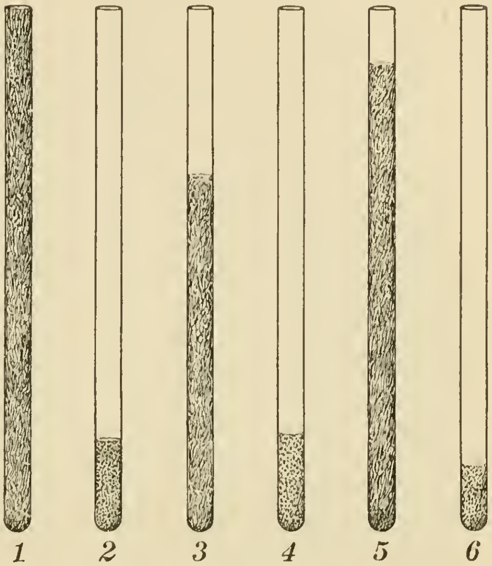


FIG. 62

Tube 1 represents one pound of redtop grass as bought; Tube 2, amount of pure redtop grass seeds in Tube 1; Tube 3, amount of chaff and dirt in Tube 1; Tube 4, amount of weed seeds in Tube 1; Tube 5, amount of total waste in Tube 1; Tube 6, amount of pure germinable seed in Tube 1

I know of one instance where a seed dealer intentionally allowed an impurity of 30 per cent to remain in the crop seeds, and this impurity was mainly of weed seeds. There were 450,000 of one kind and 288,000 of another in each pound of seed. Think of planting weeds at that rate! Sometimes three fourths of the seeds you buy are weed seeds.

In purchasing seeds the only safe plan is to buy of dealers whose reputation can be relied upon.

EXERCISE

Examine seeds both for vitality and purity. Write for Farmers' Bulletins on both these subjects. What would be the loss to a farmer who planted a ten-acre clover field with seeds that were eighty per cent bad? Can you recognize the seeds of the principal cultivated plants? Germinate some beet seeds. What per cent comes up? Can you explain? Collect for your school as many kinds of wild and cultivated seeds as you can.

Fig. 63. A Young Fruit Grower

From Hodge's "Nature Study and Life," Ginn & Company

CHAPTER IV

HOW TO RAISE A FRUIT TREE

Let each pupil grow an apple tree this year and attempt to make it the best in his neighborhood. In your attempt suppose you try the following plan. In the fall take the seed of an apple — a crab is good — and keep it in a cool place during the winter. The simplest way to do this is to bury it in damp sand. In the spring plant it in a rich, loose soil.

Great care must be taken of the young shoot as soon as it appears above the ground. You want to make it grow as tall and as straight as possible during this first year of its life; hence you should give it rich soil and protect it from animals. Before the ground freezes in the fall take up your young tree with the soil that was around it and keep it all winter in a cool, damp place.

Now it will not do when spring comes to set out your carefully tended tree, for an apple tree from seed will not be a tree like its parent, but will tend to resemble a more distant ancestor. The distant ancestor that the young apple tree is most likely to take after is the wild apple, which is small, sour, and otherwise far inferior to the fruit we wish to grow. It makes little difference, therefore, what kind of apple seed we plant, since in any event we have no assurance that the tree grown from it will bear a fruit worth having unless we force it to do so.

SECTION XXII — GRAFTING

By a process known as *grafting* you can force your tree to produce whatever variety of apple you desire. Many people raise fruit trees directly from seed without grafting. They thus often produce really worthless trees. By grafting they would make sure not only of having good trees rather than poor ones but also of having the particular kind of fruit that they wish; hence you must now graft your tree.

First you must decide what variety of apple you want to grow on your tree. The Magnum Bonum is a great favorite as a fall apple. The Winesap is a good winter apple, while the Red Astrachan is a profitable early apple, especially in the lowland of the coast region. The Northern Spy, Æsop, and Spitzenberg are also admirable species. Possibly some other apple that you know may suit your taste and needs better.

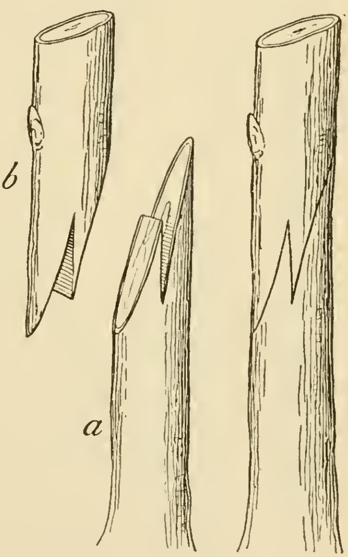


Fig. 64. Tongue Grafting

If you have decided to raise an Æsop or a Magnum Bonum or a Winesap, you must now cut a twig from the tree of your choice and graft it upon the little tree that you have raised. Choose a twig that is about the thickness of your young tree at the point where you wish to graft. Be careful to take your shoot from a vigorous, healthy part of the tree.

There are many ways in which you may join your chosen shoot or twig upon your young tree, but perhaps the best one for you to use is known as *tongue grafting*. This is illustrated in Fig. 64. The upper part, *b*, which is the shoot or twig that you cut from the tree, is known as the *scion;* the lower part, *a*, which is your original tree, is called the *stock*.

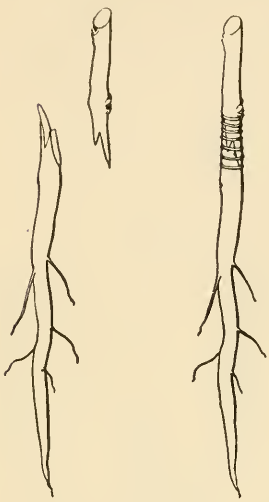


Fig. 65

A Completed Graft

Showing scion and stock from which it was made

Cut your scion and stock as shown in Fig. 64. Join the cut end of the scion to the cut end of the stock. When you join them, notice that under the bark of each there is a thin layer of soft, juicy tissue. This is called the *cambium*. To make a successful graft, the cambium in the scion must exactly join the cambium in the stock. Be careful, then, to see that cambium meets cambium. You now see why grafting can be more successfully done if you select a scion and stock of nearly the same size.

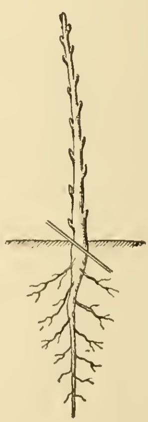


Fig. 66

To make a root graft cut along the slanting line

After fitting the parts closely together, bind them with cotton yarn (see Fig. 65) that has been coated with grafting wax. This wax is made of equal parts of tallow, beeswax, and linseed oil. Smear the wax thoroughly over the whole joint, and make sure that it is completely air tight.

The best time to make this graft is when scion and stock are dormant, that is, when not in leaf. During the winter, say in February, is the best time to graft your tree. Now set your grafted tree away again in damp sand until spring; then plant it in loose, rich soil.

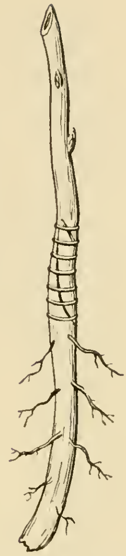


Fig. 67. A Completed Root Graft

Since all parts growing above the graft will be of the same kind as the scion, while all branches below it will be like the stock, it is well to graft low on the stock, even upon the root itself. The slanting double line in Fig. 66 shows the proper place to cut off for such grafting.

You may sometime, if you like, make the interesting and valuable experiment of grafting scions from various kinds of apple trees upon the branches of one stock. In this way you can secure a tree bearing a number of kinds of fruit. You may thus raise the Bonum, Red Astrachan, Winesap, and as many other varieties of apples

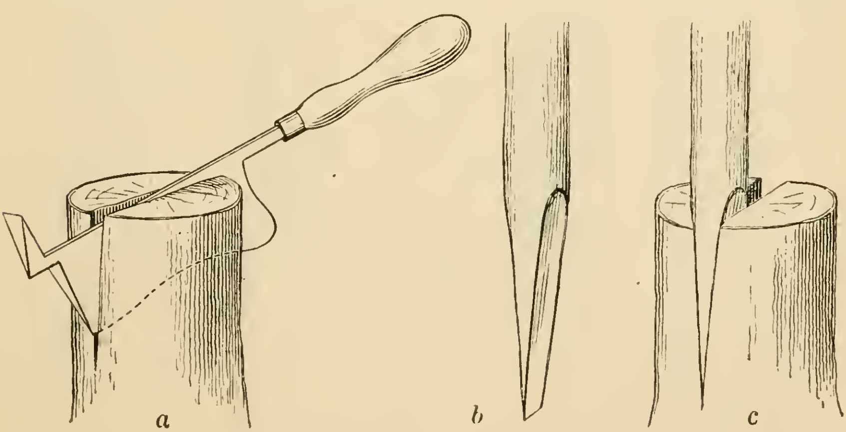


Fig. 68. Cleft Grafting

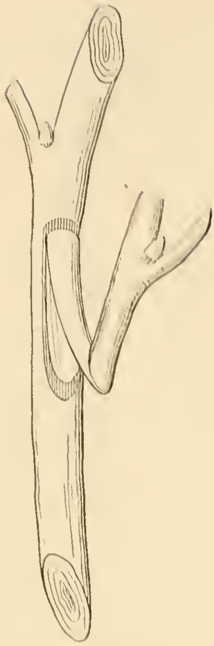


Fig. 69. How to cut a Bud from a Scion

as you wish, upon one tree. For this experiment, however, you will find it better to resort to *cleft grafting*, which is illustrated in Fig. 68.

Luther Burbank, the originator of the Burbank potato, in attempting to find a variety of apple suitable to the California climate, grafted more than five hundred kinds of apple scions on one tree, so that he might watch them side by side and determine which kind was best suited to conditions in that state.

SECTION XXIII — BUDDING

If, instead of an apple tree, you were raising a plum or a peach, you would probably in the place of grafting use budding. Occasionally budding is also employed for apples, pears,

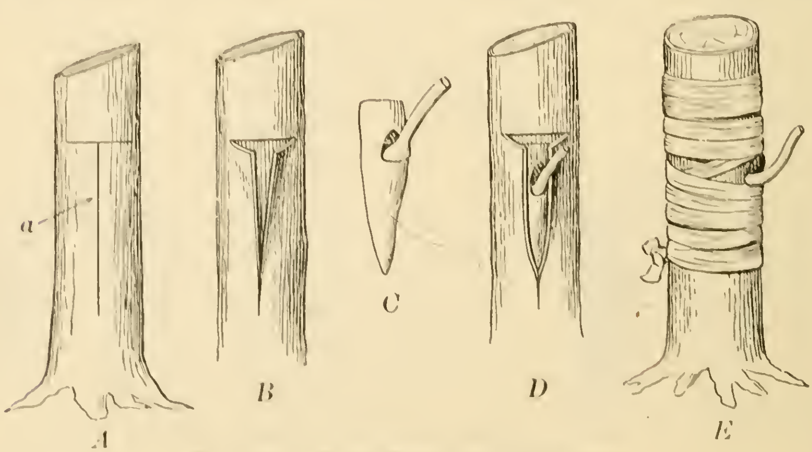


Fig. 70. The Steps in Budding

cherries, oranges, and lemons. The process is as follows. A single bud is cut from the scion and is then inserted under the bark of a one-year-old peach seedling, so that the cambium of the bud and stock may grow together.

FIG. 71
Sloping line shows where to cut tree

Cut scions of the kind of fruit tree you desire from a one-year-old twig of the same variety. Wrap them in a clean, moist cloth until you are ready to use them. Just before using cut the bud from the scion, as shown in Fig. 69. This bud is now ready to be inserted on the north side of the stock, just two or three inches above the ground. The north side is selected to avoid the sun. Now, as shown at *a* in Fig. 70, make a cross and an up-and-down incision, or cut, on the stock; pull the bark back carefully, as shown in *B*; insert the bud *C*, as shown in *D*; then fold the bark back, and wrap with yarn or raffia, as shown in *E*. As soon as the bud and branches have united, remove the wrapping to prevent its cutting the bark, and cut the tree back very close to the bud, as in Fig. 71, so as to force nourishment into the inserted bud.

FIG. 72
Lines show where to trim

Budding is done in the field without disturbing the tree as it stands in the ground. The best time to do this is during the summer or fall months, when the bark is loose enough to allow the buds to be easily inserted.

Trees may be budded or grafted upon one another only when they are nearly related. Thus the apple, crab apple, hawthorn, and quince are all related closely enough to graft or bud upon one another; the pear grows upon some hawthorns, but not well upon the apple; some chestnuts will unite with some kinds of oaks.

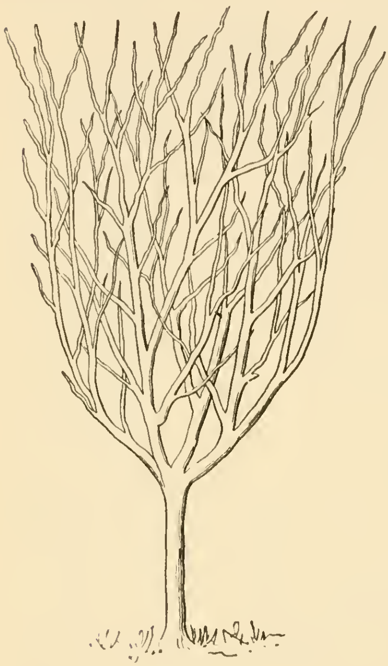


FIG. 73

Present shape comes from pruning

SECTION XXIV — PLANTING AND PRUNING

The apple tree that you grafted should be set out in the spring. Dig a hole three or four feet in diameter where you wish your tree to grow. Place the tree in the hole, using every care to preserve all the fine roots. Spread the roots out fully, water them, and pack fine, rich soil firmly about them. Place stakes about the young tree to protect it from injury. If the spot selected is in a windy location, incline your tree slightly toward the prevailing wind.

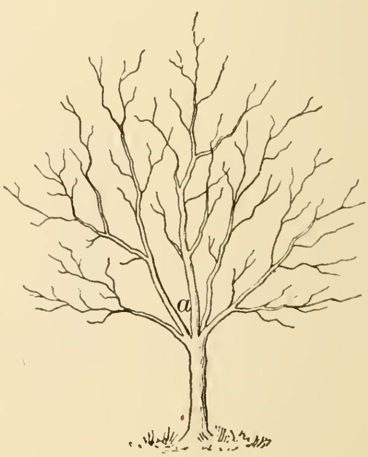


FIG. 74

You must prune your tree as it grows. The object of

pruning is to give the tree proper shape and to promote fruit bearing. If the bud at the end of the main shoot grow, you will have a tall, cone-shaped tree. If, however, the end of the young tree be cut or "headed back" to the lines in Fig. 72, the buds below this point will be forced to grow, and make a tree like that shown in Fig. 73. The proper height of heading for different fruits varies. For the apple tree a height of two or three feet is best.

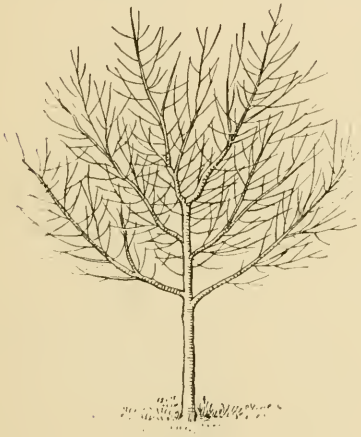


FIG. 75
Unthinned

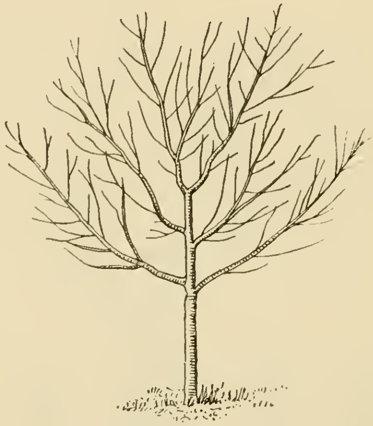


FIG. 76
Properly thinned

Cutting an end bud of a shoot or branch always sends the nourishment and growth into the side buds. Trimming or pinching off the side buds throws the growth into the end bud. You can therefore cause your tree to take almost any shape you desire. The difference between the trees shown in Figs. 73 and 74 is entirely the result of pruning. Fig. 74 illustrates in general a correctly shaped tree. It is evenly balanced, admits light freely, and yet has enough foliage to prevent sun scald. Figs. 75 and 76 show the effect of judiciously thinning the branches.

The best time to prune is either in the winter or before the buds start in the spring. Winter pruning tends to favor wood production, while summer pruning lessens wood production and induces fruitage.

Each particular kind of fruit requires special pruning; for example, the peach should be made to assume the shape

FIG. 77. THE CUSTOMARY WAY OF PRUNING A PEACH

FIG. 78. TWO YEAR-OLD TREE
Cut off heel, *h*

illustrated in Fig. 77. This is done by successive trimmings, following the plan illustrated in Figs. 71, 78, 79. You will gain several advantages from these trimmings. First, nourishment will be forced into the peach bud that you set on your stock. This will secure a vigorous growth of the scion. A second trimming will take off the "heel," *h*,

close to the tree, and thus prevent decay at this point. One year after budding you should reduce the tree to a "whip," as in Fig. 79, by trimming at the dotted line in Fig. 78. This establishes the "head" of your tree, which in the case of the peach should be very low, — that is, about sixteen inches from the ground, — in order that a low foliage may lessen the danger of sun scald to the main trunk.

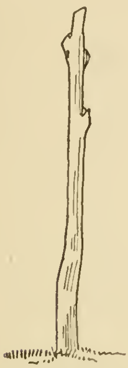


FIG. 79. THREE YEAR OLD TREE CUT BACK

In pruning never leave a stump such as is shown in Fig. 78, *h*. Such a stump having no source of nourishment will be sure to heal very slowly with great danger of decay. If this heel is cleanly cut on the line *ch* (Fig. 78), the wound will heal rapidly and with little danger of decay. Leaving such a stump endangers the soundness of the whole tree. Fig. 80 shows the results of good and poor pruning on a large tree. When large limbs are removed, it is best to paint the cut surface to prevent the access of rot-causing fungi.

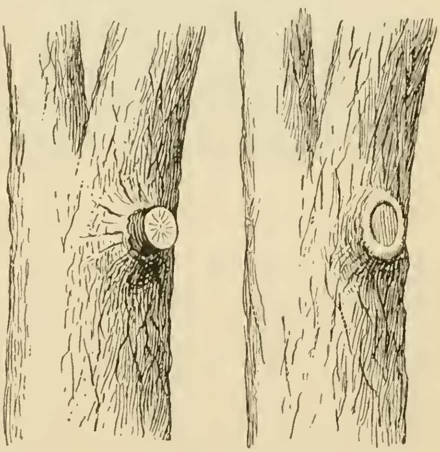


FIG. 80

Refuses to heal — Heals promptly

Pruning that leaves large limbs branching, as in Fig. 74, *a*, is not to be recommended, since the limbs when loaded with fruit or when beaten by heavy winds are liable to break. At the point

of breakage, decay is apt to set in. The entrance of decay fungi through some such wound, or even through a very tiny crevice at such a crotch, is the beginning of the end of many a fruitful tree.

Sometimes a tree will go too much to wood and too little to fruit. This often happens in rich soil, and may be remedied by another kind of pruning known as *root pruning*. This consists in cutting off a few of the roots in order to limit the food supply of the plant. You should learn more about root pruning, however, before you attempt it.

A recent writer asks and answers the following questions :

"How is a peach tree made? In 1898 a pit or seed is saved. In the spring of 1899 it is planted. The young tree comes up quickly. In August, 1899, the little stock has one bud — of the desired variety — inserted near the ground. In the spring of 1900 the stock is severed just above the bud, the bud throws out a shoot which grows to a height of four or six feet, and in the fall of 1900 the tree is sold. It is known as a year-old tree, but the root is two years old.

"How is an apple tree made? The seed is saved in 1898, planted in 1899. The seedlings do not grow so rapidly as those of the peach. At the end of 1899 they are taken up and sorted, and in the spring of 1900 they are planted. In July or August, 1900, they are budded. In the spring of 1901 the stock is cut off above the bud, and the bud shoot grows three or four feet. In 1902 the shoot branches, or the top begins to form ; and in the fall of 1902 the tree may be sold as a two-year old, although most persons prefer to buy it in 1903 as a three-year old. In some parts of the country, particularly in the West, the little seedling is grafted in the winter of 1899–1900, in a grafting room ; and the young grafts are set in the nursery row in the spring of 1900, to complete their growth."

EXERCISE

Do you know any trees in your neighborhood that bear both wild and budded or grafted fruit? What are the chief varieties of apples grown in your neighborhood? grapes? currants? plums? cherries? figs? What is a good apple tree worth? Is there any land near by that could support a tree that is not now doing so? Examine several orchards and see whether the trees have proper shape. Do you see any evidence of poor pruning? Do you find

FIG. 81. READY TO BEAR

any "heels"? Can you see any place where "heels" have resulted in rotten or hollow trees? How could you have prevented this? Has the removal of branches ever resulted in serious decay? How is this to be prevented?

If your home is not now well stocked with all the principal kinds of fruit, do you not want to propagate and attend to some of each kind? You will be surprised to find how quickly they will bear and how soon you will be eating fruit from your own planting. I assure you that growing your own trees will make you feel like a real proprietor.

CHAPTER V

THE DISEASES OF PLANTS

SECTION XXV — THE CAUSE AND NATURE OF PLANT DISEASE

Plants have diseases just as animals do; not the same diseases, to be sure, but just as serious for the plant. Some of them are so dangerous that they kill the plant; others partly or wholly destroy its usefulness or its beauty. Some diseases are found oftenest on very young plants, others prey on the middle-aged tree, while still others attack merely the fruit. Whenever a farmer or fruit grower has disease among his plants, he of course loses much profit.

You have all seen rotten fruit. This is diseased fruit. Fruit rot is a plant disease. Fruit rot costs farmers millions of dollars annually. One fruit grower lost sixty car loads of peaches in one year through rot which could have been largely prevented if he had known how.

Many of the yellowish or discolored spots on leaves are the result of disease, as is also the smut of wheat, corn, and oats, the blight of the pear, and the wilt of cotton. Many of these diseases are contagious, or, as we often hear said of measles, "catching." This is true, among others, of the apple and peach rot. A healthy apple can "catch" this disease from a sick apple. You often see evidence of

this in the apple bin. So, too, many of the diseases found in the field or garden are contagious.

Sometimes, when the skin of a rotten apple has been broken, you will find in the broken place a blue mold. It was the mold that caused the apple to decay. This mold is a living plant; very small, to be sure, but nevertheless a plant. Let us learn a little about molds, in order that we may better understand our apple and potato rots as well as other plant diseases.

If you cut a lemon and let it stand for a day or two, there will probably appear a blue mold like that you have seen on the surface of canned fruit. Bread also sometimes has this blue mold; at other times it has a black mold, and again a pink or yellow mold.

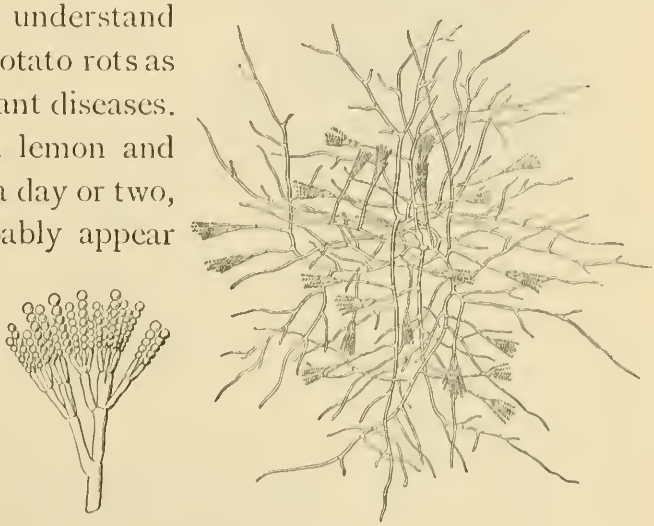


FIG. 82. TANGLED THREADS OF BLUE MOLD

The single stalk on left shows how spores are borne

These and all other molds are living plants. Instead of seeds they produce many very small bodies that serve the purpose of seeds and reproduce the mold. These are called *spores*. Fig. 82 shows how they are borne on the parent plant.

It is also of great importance to decide whether by keeping the spores away we may prevent mold. Possibly this experiment will help us. Moisten a piece of bread, then

dip a match or a pin into the blue mold on a lemon, and draw the match across the moist bread. You will thus plant the spores in a row; they are so small that perhaps you may not see any of them. Place the bread in a damp place for a few days and watch it. Does the mold grow where you planted it? Does it grow elsewhere? This experiment should prove to you that molds are living things and can be planted. If you find spots elsewhere, you must remember that these spores are very small and light and were probably blown about when you made your sowing. When you touch the moldy portion of a dry lemon, you see a cloud of dust rise. This dust is made of millions of spores.

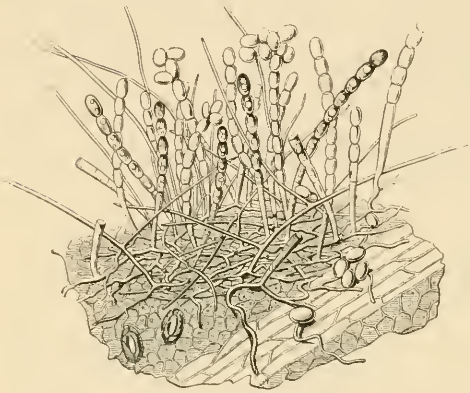


Fig. 83. Magnified Rose Mildew

If you plant many other kinds of mold, you will find that the molds "come true" to the kind that is planted; that like produces like even among molds.

Fig. 84. A Mildewed Rose

You can also prove that mold is caused only by other mold. To do this, put some wet bread in a wide-mouthed bottle and plug the opening with cotton. Kill all the spores that may be in this bottle by steaming one hour

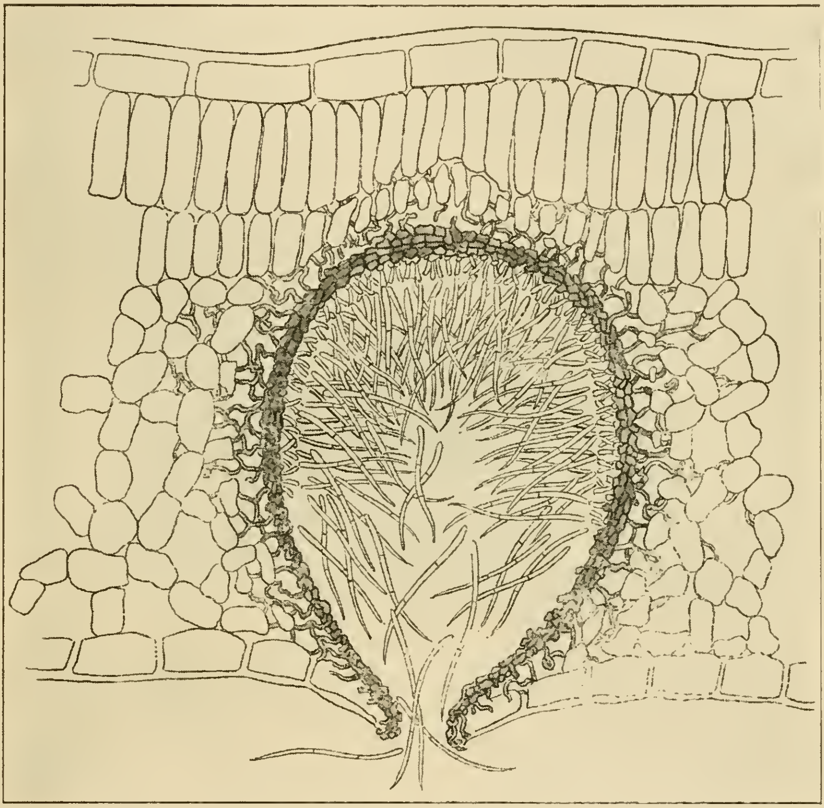


FIG. 85. A HIGHLY MAGNIFIED SECTION OF DISEASED PEAR LEAF

Showing how spores are borne

in the cooking steamer. This bread will not mold until you allow live mold from the outside to enter. If, however, at any time you open the bottle and allow spores to enter, or if you plant spores therein, and if there be moisture enough, mold will immediately set in.

The little plants which make up these molds are called *fungi*. Some fungi are quite large, as, for example, the toadstools, puffballs, and Devil's snuff-box; others very small, as the molds; and others even smaller than the molds. Fungi never have the green color of ordinary plants, always reproduce by spores, and feed on living matter or matter that was once alive. Puffballs, for example, are found on rotting wood or dead twigs or roots. Some fungi grow on living plants, and these produce plant disease by taking their nourishment from the plant which they grow upon; the latter plant is then called the *host*.

The same blue mold that grows on bread often attacks apples that have been slightly bruised; it cannot pierce healthy apple skin. You can plant the mold in the bruised apple, just as you did on bread, and watch its rapid spread through the apple. You learn from this the need of preventing bruised or decayed apples from coming in contact with healthy fruit.

Just as this fungus lives in the apple or bread, so other varieties live on leaves, bark, etc. Fig. 83 represents the surface of a mildewed rose leaf very greatly magnified. This mildew is a fungus. You can see its creeping stems, its upright stalk, and numerous spores ready to fall off and spread the disease with the first breath of wind. You must remember that this figure is greatly magnified, and that the whole portion shown in the figure is only about one tenth of an inch across. Fig. 84 shows the general appearance of a twig affected by this disease.

This mildew on the rose or on any plant so affected may be killed by spraying the leaves with a solution of liver of

sulphur; to make this solution, use one ounce of the liver of sulphur to two gallons of water.

The fungus that causes the pear leaf spots has its spores in little pits (Fig. 85). The spores of some fungi also grow on stalks, as in Fig. 86. This figure represents an enlarged view of the pear scab, which causes so much destruction.

You see, then, that fungi are living plants that grow at the expense of other plants and cause disease. Now

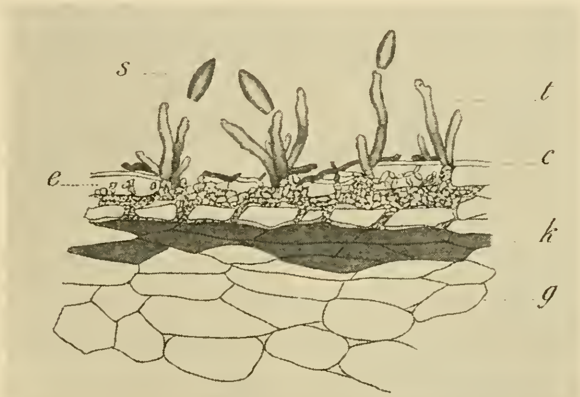


FIG. 86

The spores of the pear scab fungus are borne on stalks

if you can cover the leaf with a poison that will kill the spore when it comes, you can prevent the disease. One such poison is the Bordeaux Mixture (pronounced *bôr-dō'*), which has proved of great value to farmers.

Since the fungus in most cases lives within the leaves, the poison on the outside does no good after the fungus is established. The treatment can be used only to *prevent* attack, not to cure, except in the case of a few mildews that live upon the outside of the leaf, as does the rose mildew.

EXERCISE

Why do things mold more readily in damp places? Do you now understand why fruit is heated before it is canned? Try to grow several kinds of mold. Do you know many edible fungi?

Transfer disease from a rotten apple to a healthy one and note the rapidity of decay. How many really healthy leaves can you find on a strawberry plant? Do you find any spots with reddish borders and white centers? Do you know that this is a serious disease of the strawberry? What damage does fruit mold do to peaches, plums, or strawberries?

Write to your Experiment Station for Bulletins on plant diseases and methods for making and using the Bordeaux Mixture.

SECTION XXVI — YEAST AND BACTERIA

Can you imagine a plant so small that it would take one hundred plants lying side by side to equal the thickness of a sheet of writing paper? There are plants that are so small. Moreover, these same plants are of very great importance to man in two ways. Some of them do him great injury, while others aid him very much.

You will recognize their importance when I tell you that certain of them in their habits of life cause great change in the substances that they live in. For example, when living in a sugary substance, they change the sugar into a gas and an alcohol. Do you remember the bright bubbles of gas you have seen rising in sweet cider or in wine as it soured? These bubbles are caused by one of these small plants, the yeast plant. As the yeast plant grows in the sweet fruit juice, alcohol is made and a gas is given off at the same time, and this gas makes the bubbles.

Later, other kinds of plants equally small will grow and change the alcohol into an acid, which you will recognize by its sour taste and peculiar odor. Thus vinegar is made by the action of two different kinds of little living plants in the cider. That these are living beings you can prove by heating the cider and keeping it tightly sealed so that nothing can enter the can. You will find that, the living germs being killed by the heat, the cider will not ferment or sour as it did before. The germs could of course be killed by poisons, but then the cider would be unfit for use. It is also this same little yeast plant that causes bread to rise.

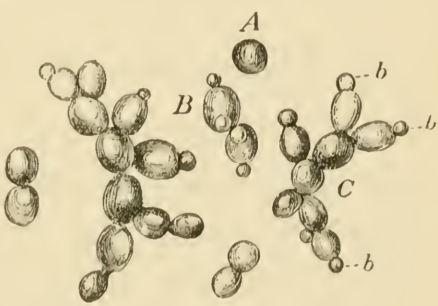


FIG. 87. YEAST PLANTS

A, a single plant; *B*, group of two budding cells

When you see any decaying matter, you may know that in it minute plants much like the yeast plant are at work. Since decay is due to them, we take advantage of the fact that they cannot grow in strong brine or smoke, and thus prepare meat for keeping by salting it or by smoking it or by both of these methods.

You see that some of the yeast plants and *bacteria*, as many of these forms are called, are very friendly to us, while others do us great harm.

Some bacteria grow within the body of man and other animals or in plants. When they do so, they may produce disease. Typhoid fever, diphtheria, consumption, and many other serious diseases are caused by bacteria. Fig. 88, *c*, shows the bacterium that causes typhoid fever.

In the picture, it is of course very greatly magnified. In reality these bacteria are so small that about twenty-five thousand of them side by side would extend only one inch. Such small beings produce such great effects by their very rapid multiplication, and by giving off very powerful poisons.

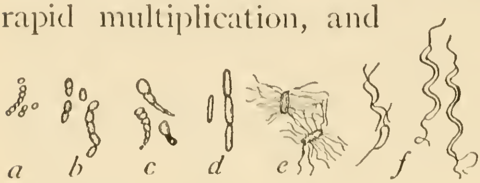


FIG. 88. FORMS OF BACTERIA

a, grippe; *b*, bubonic plague; *c*, diphtheria; *d*, tuberculosis; *e*, typhoid fever

Bacteria are so small that they are readily borne on the dust particles of the air and are often taken into the body through the breath or through water or milk. You can see how careful you should be and what precaution you should take to prevent germs from getting into the air or into water or milk when there is disease about your home. You should heed carefully all instructions of your physician on this point, so that you may not spread disease.

SECTION XXVII — PREVENTION OF PLANT DISEASES

In the last two sections you have learned something of the nature of those fungi and bacteria that cause disease in animals and plants. Now let us see how we can use this knowledge to lessen the diseases of our crops. Farmers lose through plant diseases very much that could be saved by proper precaution.

First, you must remember that every diseased fruit, twig, or leaf bears millions of spores. These must be destroyed by burning. They must not be allowed to lie about and spread the disease in the spring. See that

decayed fruit in the bin or on the trees is destroyed in the same manner. Never throw such decayed fruit into the garden or orchard, as it may cause disease the following year.

Second, you can often kill spores on seeds before they are planted, and thus prevent the development of the fungus. (See pages 107–109).

Third, often the foliage of the plant can be sprayed with a poison that will prevent the germination of the spores (see pages 111–115).

Fourth, some varieties of plants resist disease much more stoutly than others. We may often select the resistant form to great advantage (see Fig. 89).

Fifth, after big limbs are pruned off, decay often sets in at the wound. This decay may be prevented by coating the cut surface with paint, tar, or some other substance that will not allow spores to enter the wounded place or to germinate there. Many a tree could be saved by this precaution.

Sixth, it frequently happens that the spore or fungus remains in the soil. This is true in the cotton wilt, and the remedy is to so rotate crops that the diseased land is not used again for this crop until the spores or fungi have died.

SECTION XXVIII — SOME SPECIAL PLANT DISEASES

Fire Blight of the Pear and Apple. You have perhaps heard your father speak of the "fire blight" of the pear and apple trees. This is one of the most injurious and most widely known of fruit diseases. Do you want to know the cause of this disease and how to prevent it?

First, how will you recognize this disease? If the diseased bough at which you are looking has true fire blight, you will see a blackened twig with withered, blackened leaves. During winter the leaves do not fall from blighted twigs as they do from healthy ones. The leaves wither because of the diseased twig, not because they are themselves diseased. Only rarely does the blight really enter the leaf. Sometimes a sharp line separates the blighted from the healthy part of the twig.

The fire blight is caused by bacteria, of which you have read in another section. These bacteria grow in the juicy part of the stem between the wood and the bark. This tender, fresh layer is called the *cambium*, and is the part that breaks away and allows you to slip the bark off when you make your bark whistle in the spring. The growth of new wood takes place in the cambium, and this part of the twig is therefore full of nourishment. If this nourishment is stolen, the plant of course soon suffers.

The bacteria causing this disease are readily carried from flower to flower and from twig to twig by insects, and to keep all bacteria away from your trees you must see to it that all the trees in the neighborhood of your orchard are kept free from mischievous bacterial enemies. If they exist in near-by trees, insects will carry them to your orchard. You must therefore watch all the relatives of the pear; namely, the apple, hawthorn, crab, quince, and mountain ash, for any of these trees may harbor the germs.

When any tree shows blight, every diseased twig on it must be cut off and burned in order to kill the germs, and you must cut low enough on the twig to get all the bacteria. It is best to cut a foot below the blackened portion.

Fig. 89. A Resistant Variety of Sea Island Cotton

All the other plants in this field died. This one row lived because it could resist the cotton wilt

If by chance your knife should cut into wood containing the living germs, and then you should cut into healthy wood with the same knife, you yourself would spread the disease. It is therefore best after each cutting to dip your knife into a solution of carbolic acid. This will kill all bacteria clinging to the knife blade. After the leaves fall in the autumn is the surest time to do complete trimming, as it is easiest then to recognize diseased twigs, but the orchard should be carefully watched in spring also. If a large limb shows the blight, it is perhaps best to cut the tree entirely down. There is little hope for such a tree.

FIG. 90. FIRE BLIGHT BACTERIA Magnified

A large pear grower once said that no man with a sharp knife need fear the fire blight. Yet our country loses largely by this disease each year.

It may be added that winter pruning tends to make the tree form much new wood and thus favors the disease. Rich soil and fertilizers in a similar way make it much easier for the tree to "catch the blight."

EXERCISE

Ask your teacher to show you a case of fire blight on a pear or apple tree. Can you distinguish between healthy and diseased wood? Cut the twig open lengthwise and see how deep into the wood and how far down the stem the disease extends. Can you tell surely from the outside how far the twig is diseased? Can you find any twig

that does not show a distinct line of separation between diseased and healthy wood? If so, the bacteria are still living in the cambium. Cut out a small bit of the diseased portion and insert it under the bark of a healthy, juicy twig within a few inches of its tip and watch it from day to day. Does the tree "catch" the disease? This experiment may prove to you how easily the disease spreads. If you should see any drops like dew hanging from diseased twigs, touch a little of this moisture to a healthy flower and watch for results.

Cut and burn all diseased twigs that you can find. Estimate the damage done by this disease.

Farmers' Bulletin No. 153, on Orchard Enemies, published by the Department of Agriculture, Washington, D.C., can be had by writing for it, and will help your father much in treating fire blight.

Oat and Wheat Smuts. Let us go out into the oat or wheat field and look for all the blackened heads of grain that we can find. How many are there? To count accurately let us select an area one foot square. We must look sharply, for many of these blackened heads are so low that we shall not see them at first glance. You will be surprised to find as many as thirty or forty heads so blackened in every hundred. These blackened heads are due to a plant disease called *smut*.

Fig. 91. A Three Day Old Wheat Plant

Smut attacks plants only about this age

When threshing time comes, you will surely notice a great quantity of black dust coming from the grain as it passes through the machine. The air is full of it. This black dust consists of the spores of a tiny fungus plant.

The smut plant grows upon the wheat or oat plant, ripens its spores in the head, and is ready to be thoroughly scattered among the grains of wheat or oats as they come from the threshing machine.

These spores cling to the grain and at the next planting are ready to attack the sprouting plantlet. A curious thing about the smut is that it can gain foothold only on very young oat or wheat plants; that is, on plants about an inch long or of the age shown in Fig. 91.

Fig. 92. Treated and Untreated Wheat

When grain covered with smut spores is planted, the spores develop with the sprouting seeds and are ready to attack the young plant as it breaks through the seed coat. You see, then, how important it is to have seed grain free from smut. A substance has been found that will, without injuring the seeds, kill all the smut spores clinging to the grain. This substance is *formalin.* Enough seeds to plant a whole acre can be treated with this formalin at a cost of only a few cents. Such treatment insures a full crop and clean seed for future planting.

Fig. 92 illustrates what may be gained by using seeds treated to prevent smut. The annual loss to the farmers of the United States from smut on grain amounts to

several millions of dollars. All that is needed to prevent this loss is a little care in the treatment of seeds.

EXERCISE

Count the smutted heads on a patch three feet square and estimate the percentage of smut in all the wheat and oat fields near your home. On which is it most abundant? Do you know of any fields that have been treated for smut? If so, look for smut in these fields. Ask how they were treated. Do you know of any one who uses bluestone for wheat smut? Can oats be treated with bluestone?

At planting time get an ounce of formalin at your drug store or from the State Experiment Station. Mix this with three gallons of water. This amount will treat three bushels of seeds. Spread the seeds thinly upon the barn floor and sprinkle them with the mixture, being careful that all the seeds are thoroughly moistened. Cover closely with blankets for a few hours and plant very soon after treatment. Try this and estimate the per cent of smut at next harvest time. Write to your Experiment Station for a bulletin upon smut treatment.

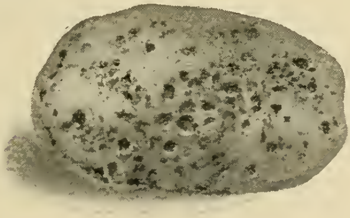


FIG. 93
A SCABBY SEED POTATO

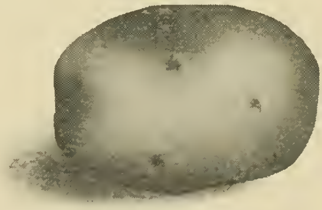


FIG. 94
A HEALTHY SEED POTATO

The Potato Scab. The scab of the white, or Irish, potato is one of the commonest and at the same time most easily prevented of plant diseases. Yet this disease diminishes the profits of the potato grower very materially. Fig. 93 shows a very scabby potato, while Fig. 94 represents a healthy one.

Fig. 95

From a scabby potato, like the one in Fig. 93, this yield was obtained

Fig. 96

From a healthy potato, like the one in Fig. 94, this yield was obtained

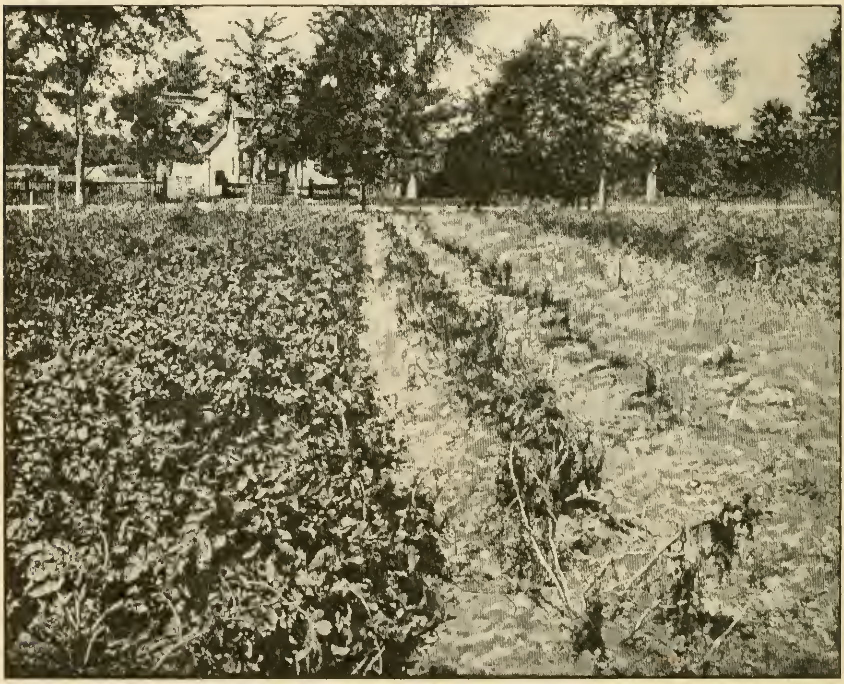


Fig. 97

Sprayed potatoes on left; unsprayed on right

This scab is caused by a fungous growth upon the surface of the potato. It of course lessens the selling price of the potatoes. If seed potatoes be treated to a bath of formalin just before they are planted, the formalin will kill the adhering fungi and greatly diminish the amount of scab at the next harvest.

Before planting, seed potatoes should be soaked in a weak solution of formalin for about two hours. One half pint of formalin to fifteen gallons of water makes a proper solution.

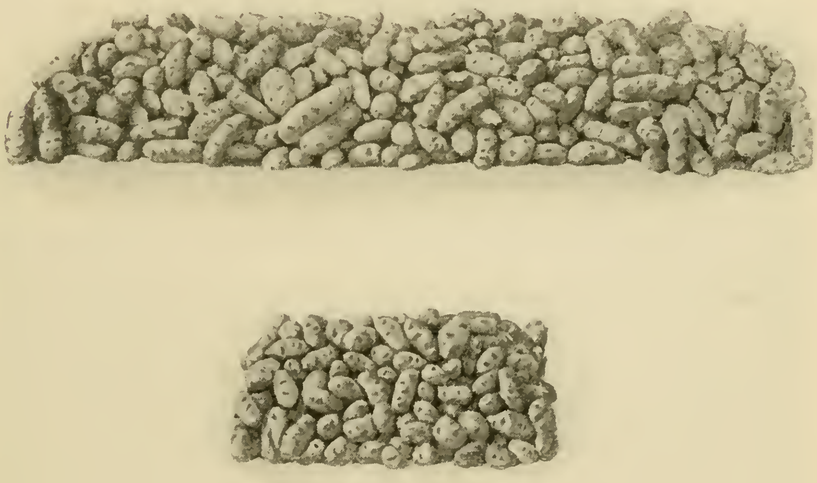


FIG. 98. YIELD FROM TWO FIELDS OF SAME SIZE

The one at top was sprayed ; the one at bottom was unsprayed

One pint of formalin, or enough for thirty gallons of water, will cost but seventy-five cents. Since this solution can be used repeatedly, it will do for many bushels of seed potatoes.

Late Potato Blight. The blight is another serious disease of the potato. This is quite a different disease from the scab and so requires different treatment. The blight

is caused by another fungus, which attacks the foliage of the potato plant. When the blight seriously attacks a crop, it generally destroys the crop completely. In the year 1845 a potato famine extending over all the United States and Europe was caused by this disease.

FIG. 99. SPRAYING MACHINE

Spraying is the remedy for this disease. Fig. 98 shows the effect of spraying upon the yield. In this case the sprayed field yielded three hundred and twenty-four bushels an acre, while the unsprayed yielded only one hundred bushels to each acre. Fig. 97 shows the result of three applications of the spraying mixture upon the

diseased field. Figs. 99 and 100 show how the spraying is done.

EXERCISE

Watch the potatoes at the next harvest and estimate the number that is damaged by scab. You will remember that formalin is the substance used to prevent grain smuts. Write to your State Experiment Station for a bulletin telling how to use formalin, as well as for

FIG. 100. SPRAYING MACHINE

information regarding other potato diseases. Give the treatment a fair trial in a portion of your field this year, and watch carefully for results. Make an estimate of the cost of treatment and of the profits. How does the scab injure the value of the potato? The late blight can often be recognized by its odor. Did you ever smell it as you passed an affected field?

The Club Root. The club root is a disease of the cabbage, turnip, cauliflower, etc. Its general effect is shown in the illustration (Fig. 101). Sometimes this disease does great damage. It can be prevented by the use of lime at the rate of from eighty to ninety bushels per acre.

The Black Knot. The black knot is a serious disease of the plum and cherry tree. It attacks the branches of the tree and is well illustrated in Fig. 102. Since it is a contagious disease, great care should be exercised to destroy all diseased branches of the wild or cultivated plums or

FIG. 101. CLUB ROOT

cherries. In many states its destruction is enforced by law. All black knot should be cut out and burned some time before February of each year. This will cost little and save much.

The Peach Curl. The peach curl does damage amounting to about $3,000,000 yearly in the United States. It can be almost entirely prevented by spraying with Bordeaux

FIG. 102. BLACK KNOT

From Hodge's "Nature Study and Life," Ginn & Company

Mixture before the buds open in the spring. A weak mixture should be used, since the leaves may be injured by too much copper.

The Cotton Wilt. Cotton wilt completely destroys the crop when it once establishes itself in the soil. The fungus

remains in the soil and no amount of spraying will avail. The only known remedy is to cultivate a resistant variety of cotton or to rotate the crop.

FIG. 103. MOLDY PEACHES

The Fruit Mold. Fruit mold, or brown rot, often attacks the unripe fruit on the tree, and turns it soft and brown and finally fuzzy with a coat of mildew. Fig. 103 shows some peaches thus attacked. Often the fruits do not fall from the trees but shrivel up and become "mummies" (Fig. 104). This rot is one of the most serious diseases of plums and peaches. It probably diminishes the value of the peach harvest from fifty to seventy-five per cent. It can be largely prevented by spraying the tree several times with the Bordeaux and other mixtures.

FIG. 104. PEACH MUMMIES

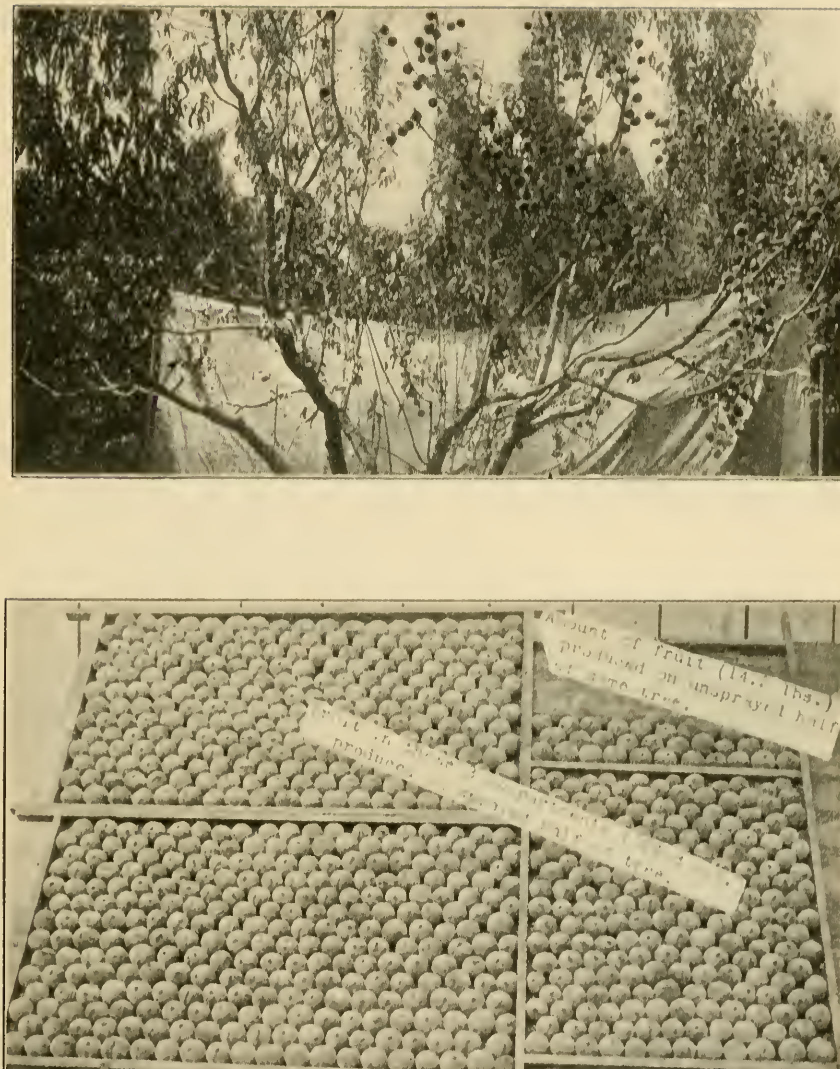


FIG. 105. HALF OF TREE SPRAYED

Note difference in foliage and fruit on the sprayed and unsprayed halves, and the difference in yield. From Bulletin No. 20 (Veg. Phys. and Path.), United States Department of Agriculture

CHAPTER VI

ORCHARD, GARDEN, AND FIELD INSECTS

SECTION XXIX — INSECTS IN GENERAL

The farmer who has fought "bugs" on crop after crop needs no argument to convince him that insects are serious enemies to agriculture. Yet even he may be surprised to learn that the damage done by them, as estimated by good authority, is as high as four hundred million dollars yearly for the United States and Canada.

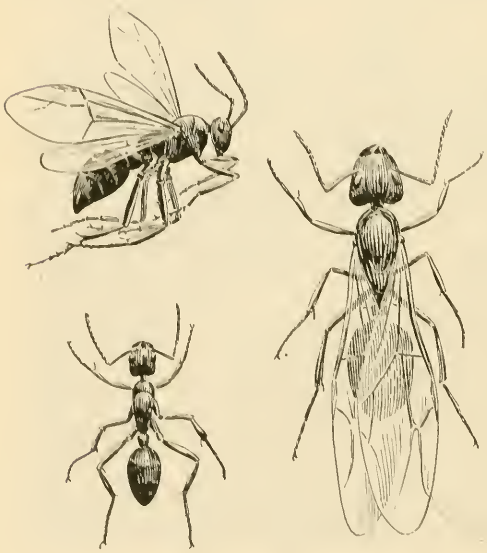


Fig. 106. Ants

Every one thinks he knows what an insect is. If, however, we are willing in this matter to make our notion agree with that of the people who have studied insects most and know them best, we must include among the true insects only such air-breathing animals as have six legs, no more, and have the body divided into three parts, — head, thorax, and abdomen. These parts are clearly shown in Fig. 106, which represents

the ant, a true insect. All insects do not show the divisions of the body so clearly as this figure shows them, but on

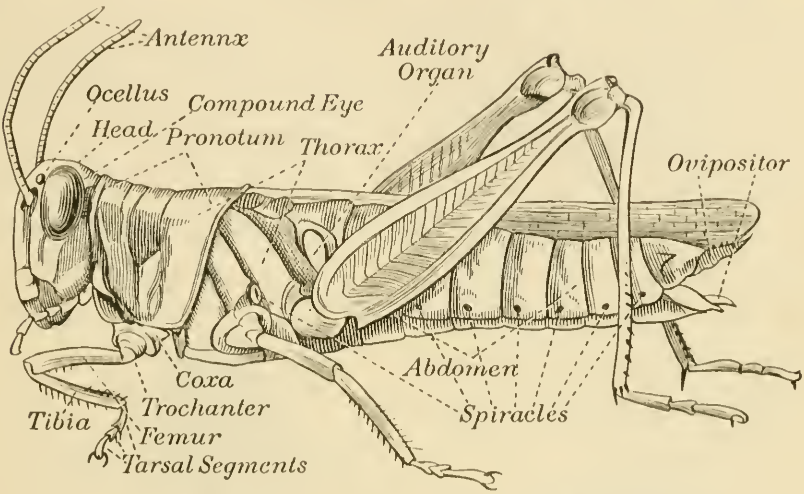


FIG. 107. PARTS OF AN INSECT

careful examination you can usually make them out. The head bears one pair of feelers, which in many insects also serve as organs of hearing and sometimes of smell. Less prominent feelers are to be found in the region of the mouth. These serve as organs of taste.

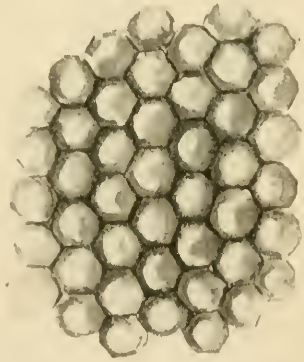


FIG. 108. COMPOUND EYE OF DRAGON FLY

The eyes of insects are conspicuous. Close examination shows them to be made up of a thousand or more simple eyes. Such an eye is called a *compound eye*. An enlarged view of one of these is shown in Fig. 108.

Attached to the thorax are the legs and also the wings, if the insect have wings. The rear portion is the abdomen,

and this, like the other parts, is composed of joints. The insect breathes through openings in the abdomen called *spiracles* (see Fig. 107).

An examination of spiders, mites, and lice shows eight legs; therefore these do not belong to the true insects, nor do the thousand-legged worms and their relatives.

The chief classes of insects are as follows: the flies, with two wings only; the bees, wasps, and ants, with four delicate wings; the beetles, with four wings, — two hard, horny ones covering the two more delicate ones. When the beetle is at rest its two hard wings meet in a straight line down the back. This peculiarity distinguishes it from the true bug, which has four wings. The two outer wings are partly horny, and in folding lap over each other. Butterflies and moths are much alike in appearance, but differ in habit. The butterfly works by day and the moth by night. Note the knob on the end of the butterfly's feeler. The moth has no such knob.

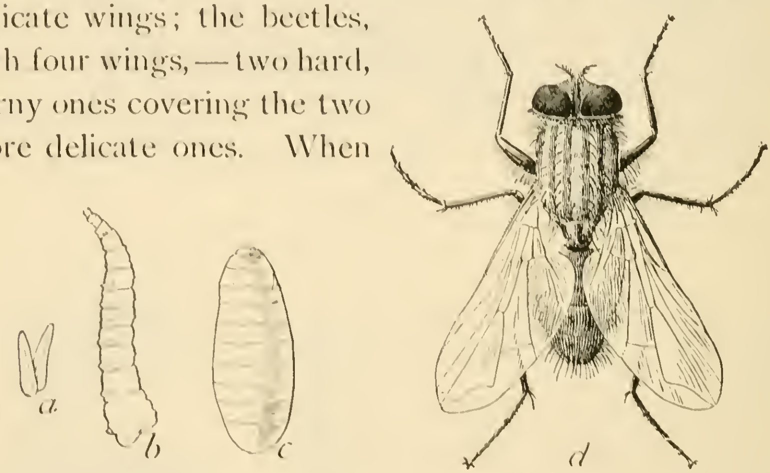


Fig. 109. The House Fly

a, egg; *b*, larva, or maggot; *c*, pupa; *d*, adult male. (All enlarged.) From Hodge's "Nature Study and Life," Ginn & Company

It is important to know how insects take their food, for by knowing this we are able oftentimes to destroy insect pests. Some are provided with mouth parts fitted to bite their food; others have a long tube with which they pierce plants or animals, and, like the mosquito, suck their food from the inside. The insects of this latter class cannot of course be harmed by poison on the surface of the leaves on which they feed.

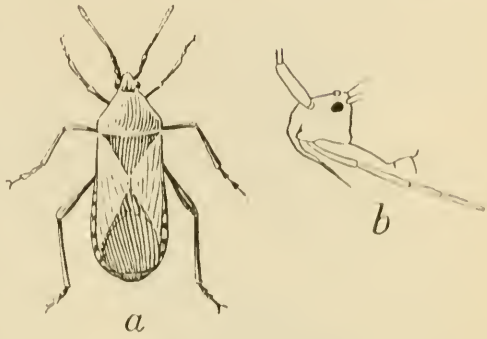


FIG. 110. A BUG
b, side view of sucking, mouth part

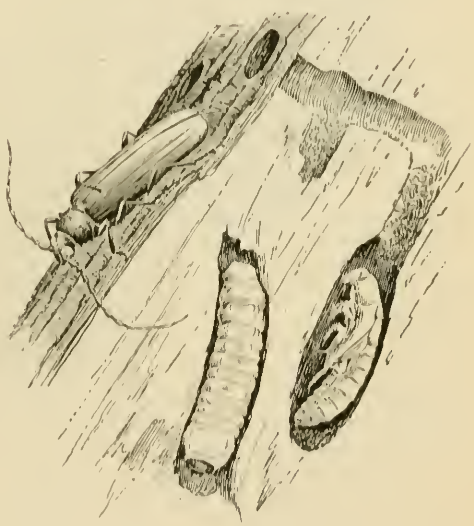


FIG. 111. BEETLE
Larva, pupa, adult, and burrow

Many insects change their form from youth to old age so much that you can scarcely recognize them as the same beings. First comes the egg. The egg hatches into a wormlike animal known as grub, or caterpillar, or more accurately *larva*. This creature settles down and spins a home of silk, called a *cocoon* (Fig. 115). If we open the cocoon, we shall find that the animal is now covered with a hard outside skeleton, and that it cannot move freely, and that

it cannot eat at all. An animal in this state is known as the *pupa* (Figs. 115 and 119). Sometimes, however, the pupa is not covered by a cocoon, is soft, and has some power of motion. After a rest in the pupa stage, the animal emerges as a mature insect (Figs. 112 and 113).

FIG. 112. MOTH AND COCOON

From Hodge's "Nature Study and Life," Ginn & Company

From this you can see that it is especially important to know all the steps in the life of injurious insects, since it is often easier to kill the pest at one stage of its life than at another. Sometimes we do better to aim at the apparently harmless beetle or butterfly than to try to destroy the

FIG. 113. BUTTERFLY

From Dickerson's "Moths and Butterflies," Ginn & Company

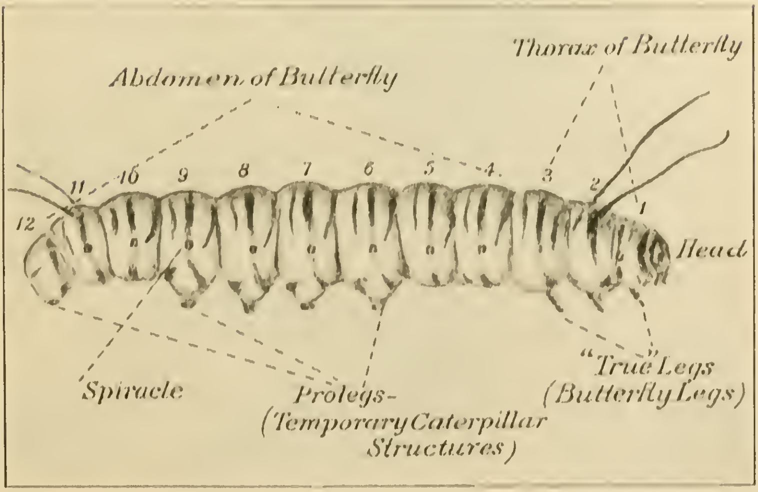


FIG. 114. STRUCTURE OF THE CATERPILLAR

From Dickerson's "Moths and Butterflies," Ginn & Company

larvæ that hatch from its eggs, since, as you must remember, it is generally the larvæ that do most harm. While in the larval stage, growth is very rapid; therefore the food supply must be very great to meet the insect's needs.

FIG. 115. MOTH PUPA IN COCOON

From Dickerson's "Moths and Butterflies," Ginn & Company

Some insects, like the grasshopper, do not completely change form. Fig. 117 represents young grasshoppers, which very closely resemble their parents.

Insects lay many eggs and reproduce with wonderful rapidity. They thus make up in number what they lack

in size. The queen honeybee often lays as many as four thousand eggs in twenty-four hours. A single house fly lays between one hundred and two hundred eggs in one night. The mosquito lays eggs in quantities of from two hundred to four hundred. The white ant often lays eighty thousand in a day, and so continues for two years, probably laying no less than forty million eggs. The blue-bottle fly in one summer has five hundred million descendants. The plant louse at the end of the fifth brood in a single year has laid six trillion eggs, and that is not all of which she is capable. Of course every one knows that owing to enemies and disease comparatively few of the insects hatched from these eggs live to be grown.

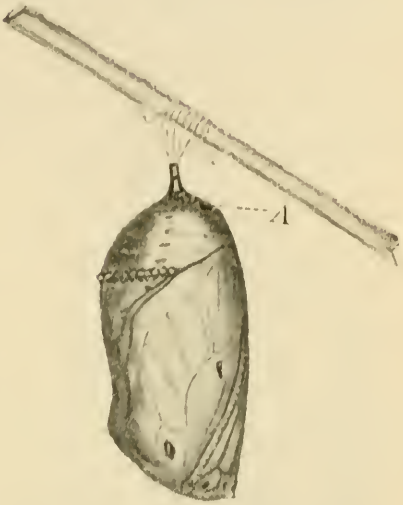


FIG. 116. A BUTTERFLY PUPA

Note outline of butterfly. (From Dickerson's "Moths and Butterflies," Ginn & Company)

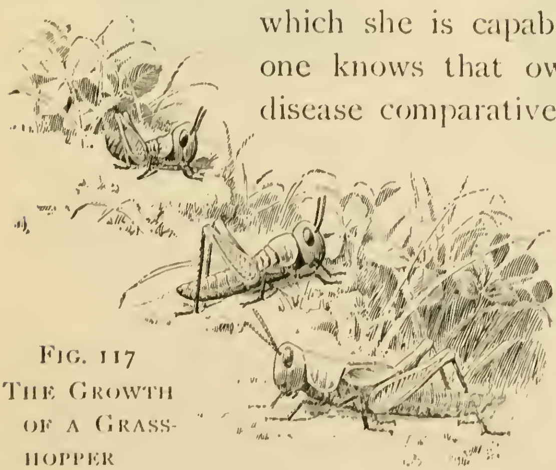


FIG. 117
THE GROWTH OF A GRASSHOPPER

EXERCISE

Collect cocoons and pupæ of insects and hatch them in a breeding cage similar to the one illustrated in Fig. 119. Make several cages of this kind. Collect larvæ of several kinds; supply them with food from plants upon

which you found them. Find out the time it takes them to change into another stage. Write a description of this process.

The plant louse produces in its twelfth brood 10,000,000,000,000,-000,000,000 offspring. These are about one tenth of an inch long. If all should live, how many miles long would such a procession be if arranged in single file?

FIG. 118. PLANT LICE

FIG. 119. CAGE IN WHICH TO BREED INSECTS

Flowerpot, lamp chimney, and cloth. (From a photograph furnished by Mrs. Anna B. Comstock, Cornell University.)

SECTION XXX — ORCHARD INSECTS

The San José Scale is one of the most dreaded enemies of fruit trees. It is in fact an outlaw in many states. It is an illegal act to sell fruit trees affected by it. Fig. 120 shows a view of a branch nearly covered with this pest.

Although this scale is a very minute animal, yet so rapidly does it multiply that it is very dangerous to the tree. Never allow new trees to be brought into your orchard without positive knowledge that they are free from the scale. If you find the scale gaining entrance to your orchard, promptly *burn the tree* affected, in order to save the others. By very vigorous spraying with kerosene

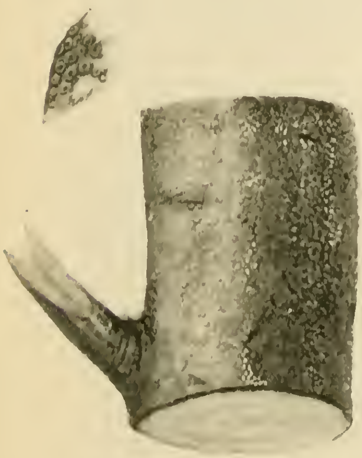


FIG. 120. SAN JOSÉ SCALE

From a drawing furnished by the United States Department of Agriculture

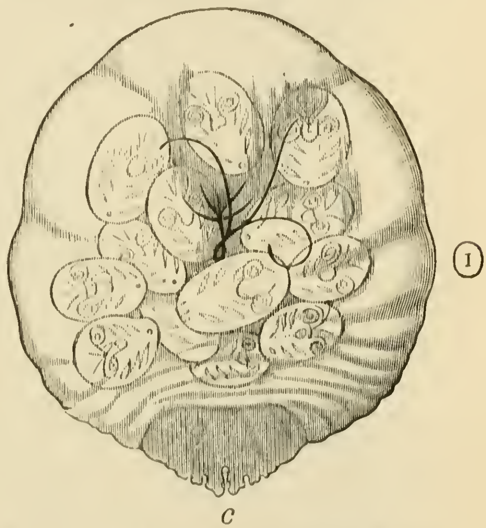


FIG. 121. SINGLE SAN JOSÉ SCALE

(Magnified.) From an engraving furnished by the United States Department of Agriculture

emulsion (see Appendix) of fifteen per cent strength you can keep these tiny animals in check; but, unless you are sure to spray properly and thoroughly, it is better to burn the trees than to run risks.

The following statement is taken from one of the Experiment Station bulletins: "We wish particularly to impress upon the minds of fruit growers that as soon as the scale is found in an orchard, the most strenuous measures must

be taken to stamp it out. No halfway measure will suffice. The individual must remember that not only are his own interests vitally at stake, but those of the entire community in which he resides. Trees badly infested should be instantly burned, as previously stated. The individual may think that

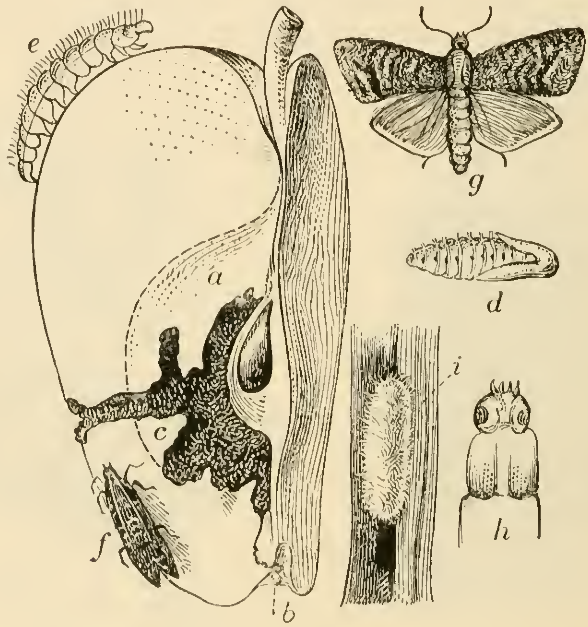


FIG. 122. THE CODLING MOTH

a, burrow of worm in apple; *b*, place where egg was laid; *c*, the larva; *d*, the pupa; *i*, the cocoon; *f* and *g*, moths

he cannot bear the loss, but the loss in consequence of the slightest neglect will be much greater. The fact, too, that there is a community of interests among fruit growers in this matter must not be lost sight of. Fruit growers must be mutually helpful in an emergency like this."

The Codling Moth attacks the apple, causing oftentimes a loss of from twenty-five to seventy-five per cent of the

FIG. 123. A TRAP FOR THE CODLING MOTH

The end of the lower band has been turned back to the left to show cocoons of the moth. (From a photograph furnished by J. M. Aldrich of the Experiment Station of Idaho.)

crop. In the state of New York this insect causes an annual loss of about three million dollars. The effect on the fruit is readily seen in Fig. 122. The moth lays the egg on the young apple just after the fall of the blossom. She flies from apple to apple, depositing an egg each time until from fifty to three hundred eggs are deposited. The larva, or "worm," soon hatches and eats its way into the apple. The affected apples ripen too soon and drop as "windfalls." The larva then emerges from the apple, moves generally to a tree, crawls up the trunk, and spins its cocoon under a ridge in the bark. From the cocoon the moth comes ready to start a new generation. The last generation of the season spends the winter in the cocoon.

Treatment. Destroy orchard trash which may serve as winter quarters. Spray the tree with Paris green as soon as the flowers fall. Trap the worms by cloth bands wrapped about the tree trunk about four weeks after the blossoms fall. The following is a practical way of trapping. Make four-inch bands of cotton flannel, burlap, or heavy paper, and fasten them closely around the trunk (Fig. 123). Since the moth nearly always climbs the tree in search of a place to spin its cocoon, and stops under the first shelter, this band will catch most of them. Collect and destroy the larvæ or cocoons that you secure once every six days. As many as one hundred and ten larvæ have been thus caught on one tree in one week. If these had all emerged as moths, how many apples could they have destroyed?

It is best to use the Bordeaux-Paris-green mixture for a spray. This prevents fungi and insects by one spraying (see Appendix).

The Plum Curculio, sometimes called the plum weevil, is a little fellow about one fifth of an inch long, that, notwithstanding its diminutive size, does, if neglected, great damage to our fruit crop. It injures the fruit by stinging it as soon as it is formed. The word *stinging* when applied to insects, and this case is no exception, means piercing the object with the egg-layer (ovipositor) and depositing the egg. Some insects occasionally use the ovipositor merely for defense. The curculio has an especially interesting

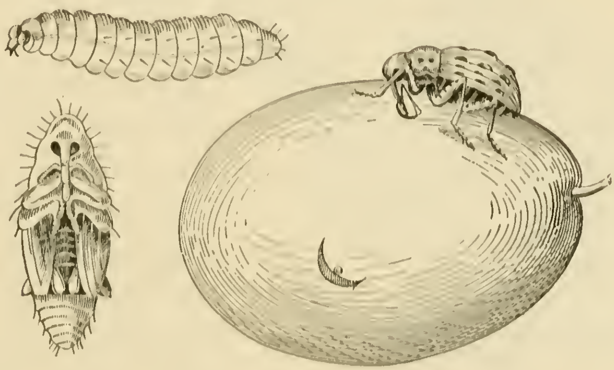


FIG. 124. PLUM CURCULIO

Larva, pupa, adult, and mark on the fruit. (Enlarged.)

method of laying its egg. First she digs a hole, places the egg in it, and pushes it well down. Then she makes a crescent-shaped cut with her snout in the skin of the plum around the egg. This mark is shown in Fig. 124. As this peculiar cut is followed by a flow of gum, you will always be able to recognize the work of the curculio. Having finished with one plum, this industrious worker shows similar courtesy to other plums until her eggs are all laid. The maggot-like larva soon hatches, burrows through the fruit, and causes it to drop before ripening. The larva then enters

the ground to a depth of several inches. There it becomes a pupa, and then a mature beetle that emerges to winter in cracks and crevices.

Treatment. Burn orchard trash which may serve as winter quarters. When the curculio is laying its eggs, it may be made to fall to the ground by jarring the tree. After its fall it will remain quiet for a few minutes, "playing possum." By spreading a sheet under the tree and jarring the tree we can collect and destroy enough insects to prevent serious injury. Jar the tree by striking a dead branch or by striking the tree with a heavy stick wrapped in cloth. Neither of these methods of jarring will injure the bark. If you have many trees to treat, you will save time by stretching sheets on frames.

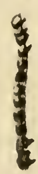
FIG. 125. LEAF GALLS OF PHYLLOXERA ON CLINTON GRAPE LEAF

Fowls in the orchard do good by capturing the larvæ before they can burrow, while hogs will destroy the fallen fruit before the larvæ can escape.

The Grape Phylloxera. This is a serious pest. You have no doubt seen its galls upon the grape leaf. These galls are caused by a small louse, the Phylloxera. Each gall contains a female, which soon fills the gall with eggs. These hatch into more females, which emerge and form new galls, and so the Phylloxera spreads.

FIG. 126
THE CANKERWORM

Treatment. The Clinton grape is most liable to injury from this pest. Hence it is better to grow other more resistant kinds. If the lice disturb the roots, apply carbon disulphide, one part of disulphide to three parts of hot water. Cover closely with earth the part treated, to prevent the evaporation of the mixture.



The Cankerworm is the larva of a moth. Because of its peculiar mode of crawling, by looping its body, it is often called the looping worm or measuring worm (Fig. 127, *c*). These worms are such greedy eaters that in a short time they can so cut the leaves of an orchard as to give it a scorched appearance. Such an attack practically destroys the crop and does permanent injury to the tree. The worm is green or brown and is striped lengthwise. If the tree is jarred, the worm has a peculiar habit of dropping

toward the ground on a silken thread of its own making (Fig. 126).

In early summer the larvæ burrow within the earth, pupate, and later emerge as adults (Fig. 127, *d* and *e*). You observe the peculiar difference between the wingless female, *d*, and the winged male, *e*. It is the habit of this wingless

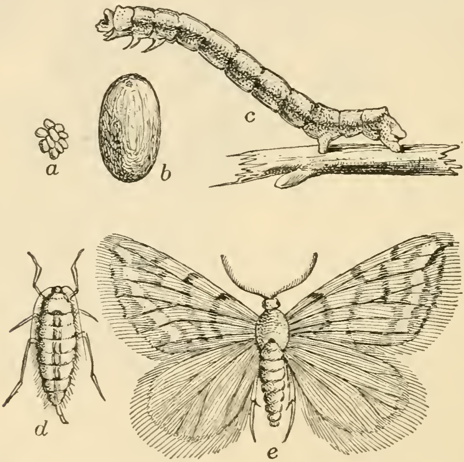


FIG. 127. THE SPRING CANKERWORM

a, egg mass; *b*, egg, magnified; *c*, larva; *d*, female moth; *e*, male moth

female to crawl up the trunk of some near-by tree in order to deposit her eggs upon the twigs. These eggs hatch into the greedy larvæ that do so much damage to our orchards.

Nearly all of the common birds feed freely upon the cankerworm, and benefit the orchard in so doing. The chickadee is perhaps the most useful. "A recent writer is very positive that each chickadee will devour on an average

thirty female cankerworm moths a day. . . . If the average number of eggs laid by each female is one hundred and eighty-five, one chickadee would thus destroy in one day five thousand five hundred and fifty eggs, and in the twenty-five days in which the cankerworm moths crawl up the tree, would rid the orchard of one hundred and thirty-eight thousand seven hundred and fifty." These birds also eat immense numbers of cankerworm eggs before they hatch into worms.

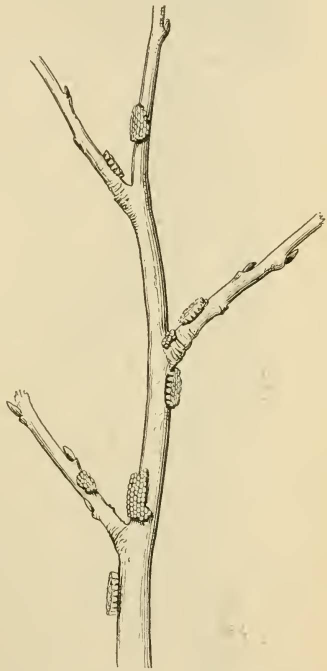


FIG. 128. EGGS OF THE FALL CANKERWORM

Treatment. The inability of the female to fly gives us an easy opportunity to prevent the access of the larval offspring to the foliage of our trees, for we know that the only highway open to her or her larvæ leads up the trunk. We must obstruct this highway so that no crawling creature may pass. This is readily done by smoothing the bark and fitting close to it a band of paper, making sure that it is tight enough to prevent anything from crawling underneath. Then smear over the paper something so sticky that any moth or larva that attempts to pass will be entangled. Printer's ink will do very well, or you can buy either dendrolene or raupenleim.

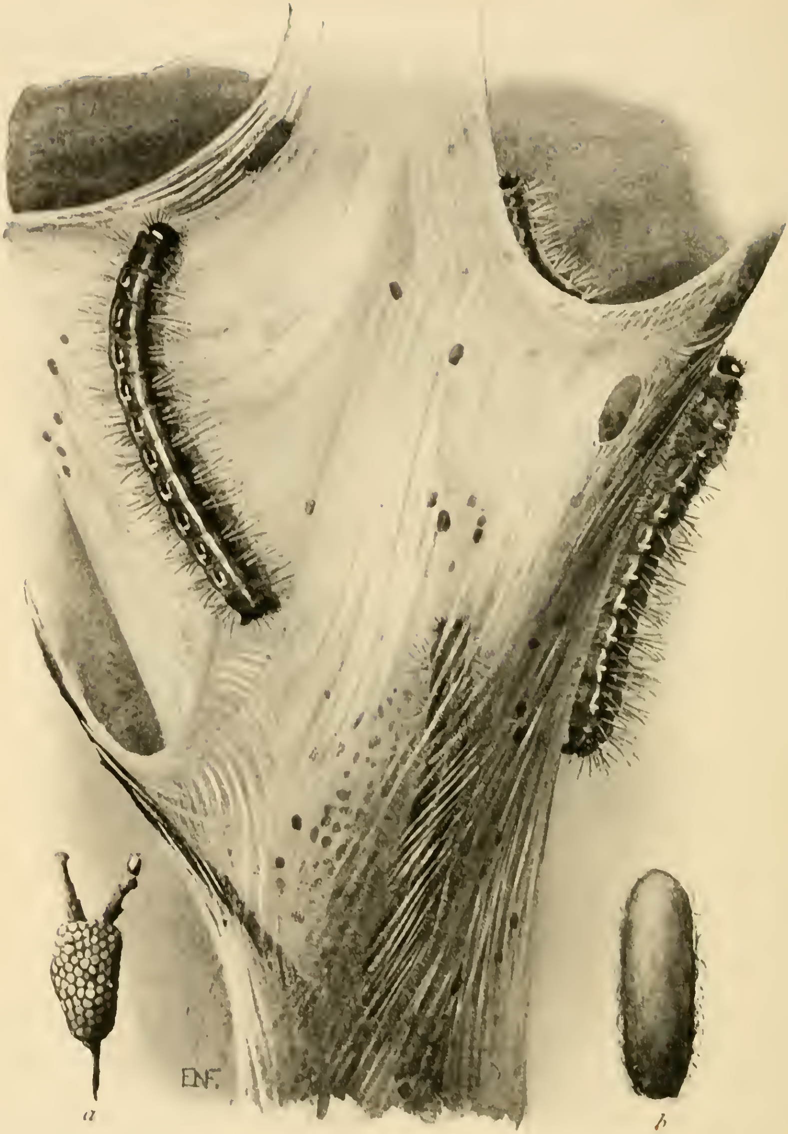


FIG. 129. APPLE-TREE TENT CATERPILLAR

a, eggs; *b*, cocoon

Encourage the chickadee and all other birds, except the English sparrow, to stay in your orchard. This is easily done by providing food in time of need and by protection at all times.

The Apple-Tree Tent Caterpillar is a larva so well known that you only need to be told how to guard against it. The mother of this caterpillar is a reddish moth. This insect passes the winter in the egg state on the twigs (Fig. 129, *a*).

Treatment. There are three chief methods. (1) Destroy the eggs. The egg masses are readily seen in winter and may easily be collected and burned by boys. The chickadee eats great quantities of these eggs. (2) With torches burn nests at midday when all the worms are within. You must be very careful in burning or you will harm the young branches with their tender bark. (3) Encourage the residence of birds. Urge your neighbors to make war on the larvæ, too, since the pest spreads readily from farm to farm. Regularly sprayed orchards are rarely troubled by this pest.

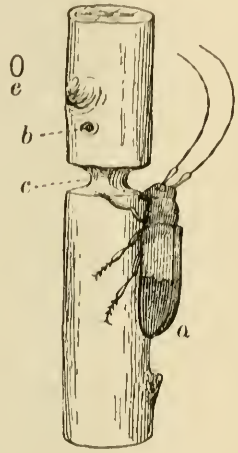


FIG. 130. THE PEAR-TREE GIRDLER AT WORK

a, the girdler; *b*, the egg hole; *c*, the groove cut by girdler; *e*, the egg

The Pear-Tree Girdler lays her eggs in the upper part of the twig. It is necessary that the larvæ develop in dead wood. This the mother provides by girdling the twig so deeply that it will die and fall to the ground.

Treatment. Since the larvæ spend the winter in the dead twigs, burn these twigs in autumn or early spring, and thus destroy the pest.

Peach Borer. In Fig. 131 you see the effect of the borer's activity. These borers often girdle and thereby kill the tree. Fig. 132 shows the perfect state of the insect. The eggs are laid on the peach or plum trees near the ground. As soon as the larva emerges, it bores into

FIG. 131. BORER SIGNS AROUND BASE OF PEACH TREE

From Hodge's "Nature Study and Life," Ginn & Company

the bark and there remains for months, passing through the pupa stage before it comes out to lay eggs for another generation.

Treatment. If there are only a few trees in the orchard, digging the worms out with a knife is the best way of destroying them. You can know of the borer's presence by the exuding gum often seen on the tree trunk.

EXERCISE

How many apples per hundred do you find injured by the codling moth? Collect some cocoons from a pear or apple tree in winter, place in a breeding cage, and watch for the moths that come out. Do you ever see the woodpecker hunting for these same cocoons? Can you find

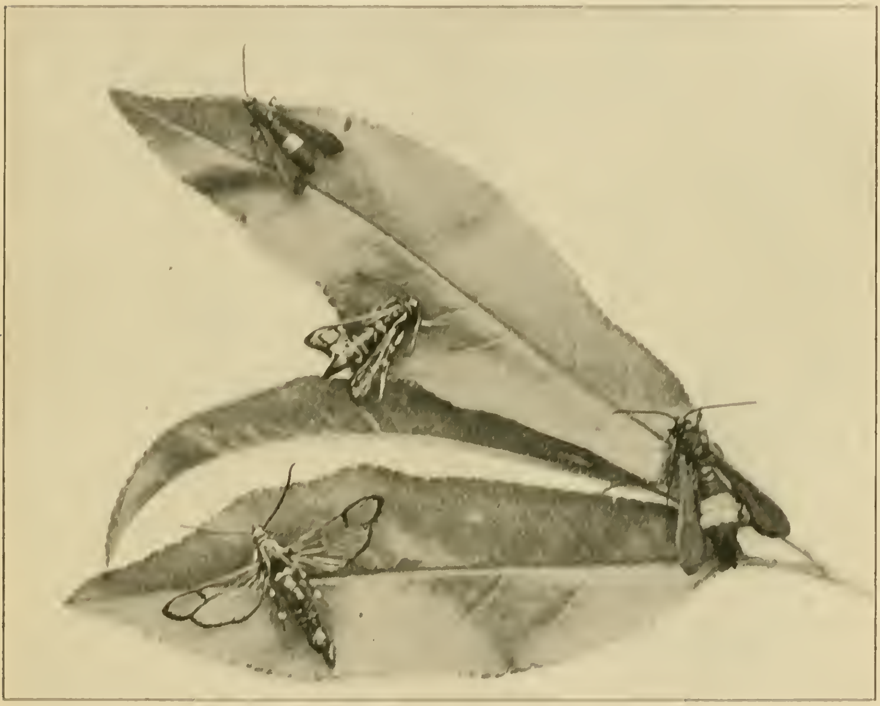


FIG. 132. PEACH TREE BORERS, MALE AND FEMALE

Female with broad yellow band across abdomen. (From Hodge's "Nature Study and Life," Ginn & Company.)

cocoons that have been emptied by this bird? Estimate how many he considers a day's ration. How many apples does he thus save?

Watch the curculio lay her eggs in the plums, peaches, or cherries. What per cent of fruit is thus injured? Estimate the damage.

Let the school offer a prize for the greatest number of tent caterpillar eggs. Watch all trees, such as apple, wild and cultivated cherry, oak, and many others.

Make a collection of insects injurious to orchard fruits, showing in each case the whole life history of the insect, i.e. eggs, larva, pupa, and the mature insects.

SECTION XXXI — GARDEN AND FIELD INSECTS

The Cabbage Worm of the early spring garden is a familiar object, but you may not know that the innocent-looking butterfly hovering here and there about the cabbage patch is laying eggs which are soon to hatch and make the dreaded cabbage worms. Fig. 134 shows the butterfly and several stages of the larvæ. Fig. *d* shows the pupa case. You may find these cases during winter on trees, fences, and under boards and stones. If you kill these pupæ, you have the satisfaction of knowing that you have prevented many cabbage worms that would have worked mischief the following year.

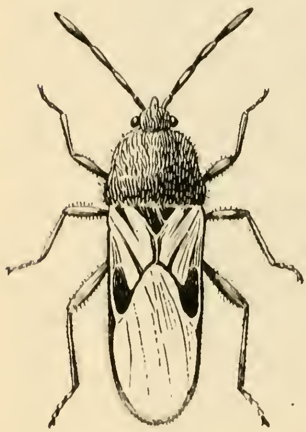


FIG. 133
THE CHINCH BUG

Treatment. Birds are a great aid in the destruction of this pest. Paris green on young plants will also kill many larvæ. After the cabbage has headed, it is very difficult to destroy the worm.

The Chinch Bug, attacking as it does such important crops as wheat, corn, and grasses, is a well-known pest. It probably causes more money loss than any other garden or field enemy. In Orange County, North Carolina, farmers were once obliged to suspend wheat growing for two years on account of the chinch bug. In one year in the state of Illinois this bug caused a loss of four million dollars.

FIG. 134. THE CABBAGE WORM AND BUTTERFLY

From original furnished by Minnesota Experiment Station

Treatment. Unfortunately we cannot prevent all of the damage done by chinch bugs, but we can diminish it somewhat by good clean agriculture. Destroy their winter quarters by burning dry grass, leaves, and rubbish in fields and fence rows. Although the insect has wings, it seldom uses them, usually traveling on foot; therefore a deep furrow around the field to be protected will impede or stop the progress of an invasion. The bugs fall into the bottom of the furrow, and may there be killed by spraying with kerosene emulsion. Write to the Division of Entomology, Washington, for Bulletin 15, on the chinch bug. Other methods of prevention are to be found in that bulletin.

FIG. 135. THE PLANT LOUSE

The Plant Louse is very diminutive, but is one of the most prolific of animals. During the summer the young are born alive, and it is only toward fall that eggs are resorted to. The individuals that hatch from eggs differ from those born alive in that they have wings, and can move more rapidly from place to place.

The plant louse gives off a sweetish fluid of which some ants are very fond. You may often see the ants stroking these lice to induce them to give off a more copious flow of the "honey dew." This is really a method of milking.

However friendly and useful these "cows" may be to the ant, they are enemies to man. You may sometimes find your plant actually covered with these minute creatures.

Treatment. These are sucking insects. Poisons therefore do not avail. They may be killed by spraying with kerosene emulsion.

The Squash Bug does its greatest damage to young plants. To such its attack is often fatal. On larger plants single leaves may die. This insect is a serious enemy to a crop, and is particularly difficult to get rid of, since it belongs to the class of sucking insects, not to the biting insects. For this reason poisons are useless.

Treatment. About the only practicable remedy is to pick these insects by hand. We can, however, protect our young plants by small nettings, and thus tide them over the most dangerous period of their lives. The bugs greatly prefer the squash as food. You can, therefore, diminish their attack on your melons, cucumbers, etc., by planting among the melons an occasional squash plant as a "trap plant." Hand picking will be easier on a few trap plants than over the whole field. A small board laid beside the young plant often furnishes night shelter for the bugs. The bugs collected under the board may easily be killed every morning.

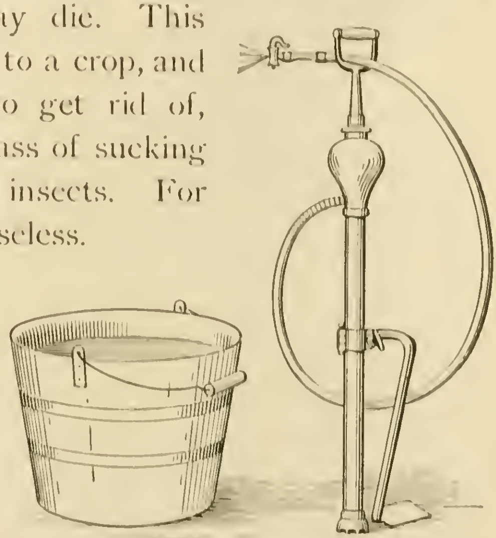


FIG. 136. A CHEAP SPRAYING OUTFIT

The Flea-Beetle inflicts much damage on the potato, tomato, eggplant, and other garden plants. The accompanying figure shows the work of the flea-beetle upon the tomato. The larva of this beetle lives inside of the leaves, mining its way through the leaf in a real tunnel. Any substance disagreeable to the beetle, such as plaster, soot, ashes, or tobacco, will repel its attacks upon the garden.

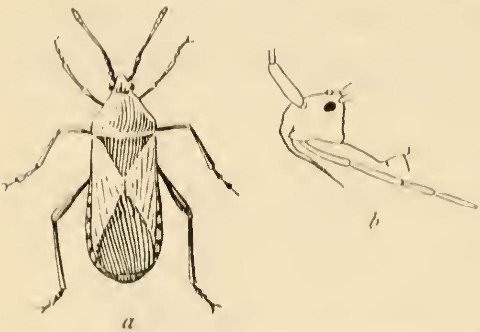


FIG. 137. A SQUASH BUG

The Weevil is commonly found among seeds. Attacks of this insect are serious, but the insect may be easily destroyed.

Treatment. Put the infected seeds in a tight box or bin, placing on the top of the pile a dish containing carbon disulphide, one teaspoonful to each bushel of seeds. The fumes of this substance are heavy and will pass through the mass of seeds below and kill all the weevils and other animals there. The bin should be closely covered with canvas, or heavy cloth, to prevent the fumes from being carried away by the air. Let the seeds remain thus from two to five days. *Caution:* Do not approach the bin with a light, since the fumes of the chemical used are highly inflammable.

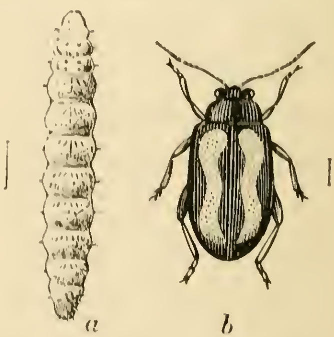


FIG. 138. FLEA-BEETLE AND LARVA

Lines on sides show real length of insects

The Hessian Fly does more damage to the wheat crop than all other insects combined, and probably ranks next to the chinch bug as the second worst insect enemy of the farmer. It was probably introduced into this country by the Hessian troops in the war of the Revolution.

In autumn the insect lays its eggs in the leaves of the wheat. These hatch into the larvae, which move down into the ground, where they pass the winter. There they cause on the plant a slight gall formation, which injures the plant. In spring an attack is made higher up on the stalk of the plant.

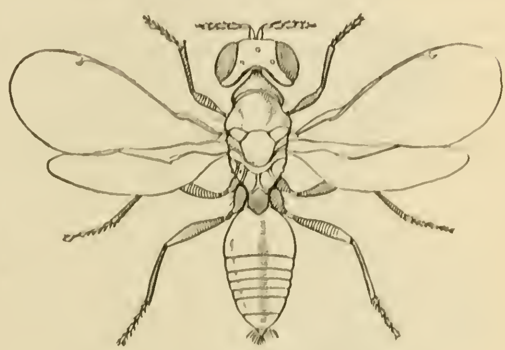


FIG. 139. THE HESSIAN FLY

Treatment. Burn all stubble and trash to kill the wintering insects. If the fly is very bad, it is well to leave the stubble unusually high to insure a rapid spread of the fire. Burn refuse from the threshing machine, since this often harbors many eggs. Some people advocate planting a decoy, or trap strip, of earlier wheat to catch the fly, and then destroying this strip with the flies on it. This method has not yet been thoroughly tried. If you wish to try it, be sure to turn your decoy crop under so deep that the fly cannot come to the surface.

The Potato Beetle, Tobacco Worm, etc., are too well known to need description. Suffice it to say that no good farmer will neglect to protect his crop from any pest that threatens it.

The increase, owing to various causes, of insects, of fungi, of bacterial diseases, makes a study of these pests,

of their origin, and of their prevention a necessary part of a successful farmer's training. Tillage alone will no longer render orchard, vineyard, and garden fruitful. Protection from disease must be added to tillage.

In dealing with plants, as with human beings, the great object should be, not the cure, but the prevention

FIG. 140. INCREASING THE YIELD OF FRUIT

of disease. It is far too costly to wait for disease to develop and then to attempt its cure if the disease can be prevented.

EXERCISE

How many chinch bugs can you find in winter condition? Are they worse in wet or dry weather? On what crops are they found?

How does the squash bug resemble the plant louse? Is this a true bug? Gather some eggs and watch the development of the

insects in a breeding cage. Estimate the damage done to some crops by the flea-beetle. What is the best method of prevention?

Do you know the large moth that is the mother of the tobacco worm? You may often see her visiting the blossoms of the Jimson weed. Some tobacco growers cultivate a few of these weeds in a

FIG. 141. PROPERLY CARED FOR

tobacco field. In the blossom they place a little cobalt or "fly-stone" and sirup. When the tobacco-worm moth visits this flower and sips the poisoned nectar, she will of course lay no more troublesome tobacco-worm eggs.

CHAPTER VII

FARM CROPS

Every crop of the farm has been changed and improved greatly since the forefathers of that crop were wild plants. Those plants that best serve the needs of the farmer and farm animals have undergone the greatest changes and have received also the greatest care and attention in their production and improvement.

While we have very many different kinds of farm crops, the greater part of the cultivated area of the world is occupied by a very few. The crop that is most valuable and that occupies the greatest land area is generally called the *grass crop*. Included in the general term *grass crop* are all the various grasses and clovers that are used for pasturage and for hay. Next to grass in value come the two great cereals, corn and wheat, closely followed by the greatest fiber crop, cotton. Oats rank fifth in value, potatoes sixth, and tobacco seventh.

Success in growing any crop is most largely due to the suitableness of soil and climate to that crop. When the planter selects both the most suitable soil and the most suitable climate for each crop, he gets not only the most bountiful yield from the crop, but in addition he gets the most desirable quality of product. A little careful observation and study soon teach what kinds of soil produce crops of the highest excellence. This learned, the planter

is able to grow in each field the several crops best adapted to that special type of soil. Thus we have tobacco soils, trucking soils, wheat and corn soils. Dairying succeeds best in a section where crops like cowpeas, clover, alfalfa, and corn are peculiarly at home.

FIG. 142. A COTTON PLANT

The figures below give the average amount of money made annually per acre on our chief crops.

AVERAGE VALUES PER ACRE OF THE VARIOUS CROPS

Flowers and plants, $2014; nursery products, $170; onions, $138; sugar cane, $87; small fruits, $81; hops, $73; vegetables, $54; tobacco, $52; sweet potatoes, $37;

hemp, \$34; potatoes, \$33; sugar beets, \$30; sorghum cane, \$21; cotton, \$15; orchard fruits, \$14; peanuts, \$14; flaxseed, \$9; cereals, \$8; hay and forage, \$8; castor beans, \$5 (United States Census Report).

SECTION XXXII — COTTON

Although cotton was cultivated on the Eastern continent before America was discovered, this crop owes its present imperial place in the business world to the zeal and intelligence of its American growers. So great an influence does it wield in modern industrial life that it is often called King Cotton. Thousands upon thousands of people scan the newspapers each day to see what price its staple is bringing. From its bounty a vast army of toilers, who plant its seed, who pick its bolls, who gin its staple, who spin and weave its lint, who grind its seed, who refine its oil, draw daily bread. Does not its proper production deserve the best thought that can be given it?

In the cotton belt almost any well-drained soil will produce cotton. The following kinds of soil are admirably suited to this plant: red and gray loams with good clay subsoil; sandy soils over sandstone and limestone; rich, dry bottom lands. The safest soils are medium loams. Cotton land must always be well drained.

Cotton was originally a tropical plant; but, strange to say, it seems to thrive best in temperate zones. The cotton plant does best, according to Newman, in climates which have (*a*) six months of freedom from frost; (*b*) a moderate, well-distributed rainfall during the plant's growing

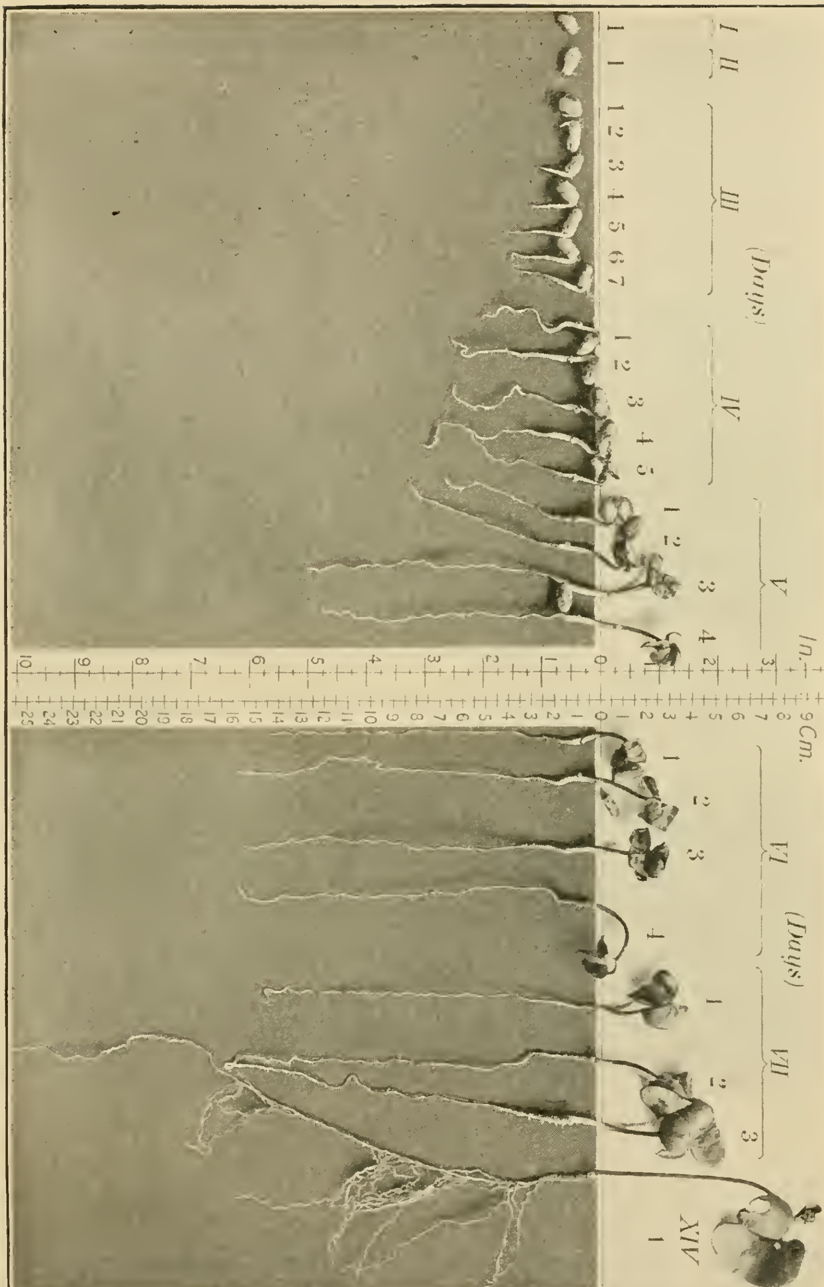


FIG. 143. GROWTH FROM DAY TO DAY

period; (*c*) abundant sunshine and little rain during the plant's maturing period.

In America, the Southern States from Virginia to Texas have these climatic qualities, and it is in these states that the cotton industry has been developed until it is one of the giant industries of the world. This development has been very rapid. As late as 1736 the cotton plant was grown as an ornamental flowering plant in many front yards; in 1899, 11,199,994 bales of cotton were grown in the South.

There are a great many varieties of cotton. Only two of these, however, are of much interest to the practical American farmer. These are (1) the short-stapled, upland variety most commonly grown in all the Southern States;

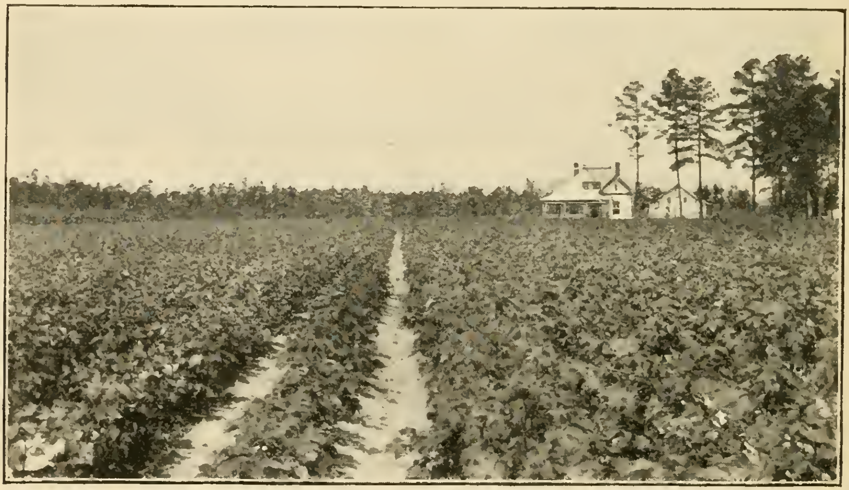


FIG. 144. IN THE GROWING SEASON

and (2) the beautiful, long-stapled, black-seeded sea-island variety that grows upon the islands and a portion of the mainland of Georgia, South Carolina, and Florida. The air of the coast seems necessary for the production of

this latter variety. The seeds of this sea-island cotton are small, smooth, and black. They are so smooth and stick so loosely to the lint that they are separated from the lint by roller instead of saw gins. When these seeds are

Fig. 145. Ready for Picking

planted away from the soil and air of their ocean home, they increase in size and stickiness.

Many attempts have been made to increase the length of the staple of the upland varieties. Some of the methods tried were as follows: selection of seed having a long fiber; special cultivation and fertilization; crossing the short-stapled variety on the long-stapled variety. This last process, as already explained, is called *hybridizing*. Some of these attempts have, in a measure, succeeded, and every farmer ought to plant seed from the longest-stapled variety that his land will grow. Moreover, his seed should be selected from the stalks that have the largest bolls and the greatest number to the stalk.

The cotton plant is nourished by a tap root that will seek food as deeply as loose earth will permit it to penetrate; hence

the first plowing, unless the land is a loose, sandy loam, should be done with a two-horse plow, and should be deep and thorough. This deep plowing not only allows the tap root to penetrate, but it also admits a circulation of air.

On some cotton farms it is the practice to break the land in winter or early spring and then let it lie naked until planting time. This is not a good practice. The winter rains wash more plant food out of unprotected soil than a single crop would use. It would be better, in the late summer or fall, to plant crimson clover or some other protective and enriching crop on land that is to be planted in cotton in the spring. This crop, in addition to keeping the land from being injuriously washed, would greatly help the coming cotton crop by leaving the soil full of vegetable matter.

Just before planting time, the plowed land should be harrowed until the soil is fine and mellow. Do not spare the harrow at this time. It destroys many a weed that, if allowed to grow, would have to be cut by costly hoeing. Thorough work before planting saves much expensive work in the later days of the crop. Moreover, no man can afford to allow his plant food and moisture to go to nourish weeds even for a short time.

The rows should be from three to four feet apart. The width depends upon the richness of the soil. On rich land the rows should be at least four feet apart. This width allows the luxuriant plant to branch and fruit well. On poorer lands the distance of the rows should not be so great. The distribution of the seed in the row is of course most cheaply done by the planter. As a rule, it is best not to ridge the land for the seed. Flat culture saves

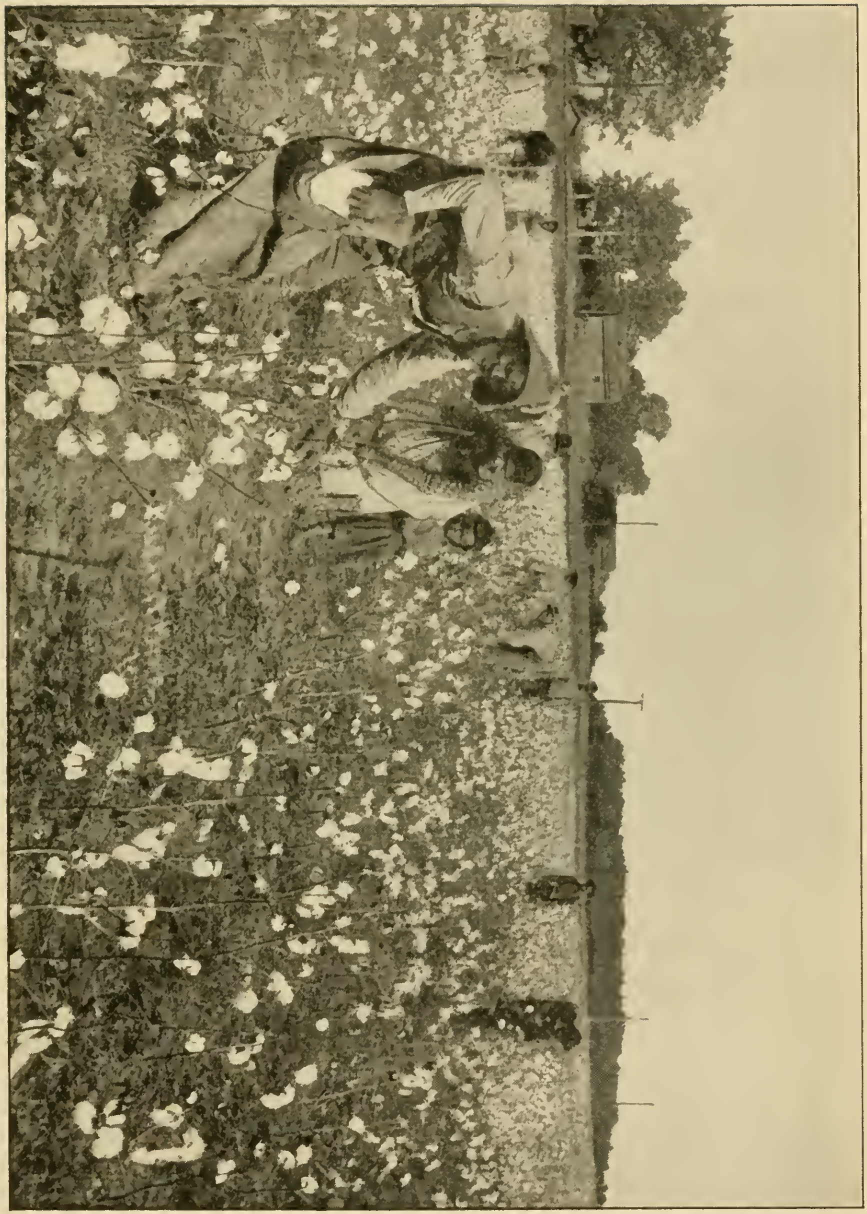


Fig. 146. Picking Cotton

moisture and often prevents damage to the roots. In some sections, however, where the land is flat and full of moisture, ridging seems necessary.

The cheapest way of cultivating a crop is to prevent grass and weeds from rooting, not to wait to destroy them after they are well rooted. To do this, it is well to run the two-horse smoothing-harrow over the land, across the rows, a few days after the young plants are up. Repeat the harrowing in six or eight days. In addition to destroying the young grass and weeds, this harrowing also removes many of the young cotton plants and thereby saves much hoeing at "chopping out" time. When the plants are about two inches high, they are "chopped out" to secure an evenly distributed stand. It is customary to leave two stalks to a hill.

The number of times the crop has to be worked depends upon the soil and season. If the soil is dry and porous, cultivate as often as possible, and especially after each rain. Never allow a crust to form after a rain; the roots of plants must have air. Cultivation after each rain forms a dry mulch on the top of the soil and thus prevents the rapid evaporation of moisture.

If the fiber (the lint) only is removed from the land on which cotton is grown, cotton is the least exhaustive of the great crops grown in the United States. According to some recent experiments, an average crop of cotton removes in the lint only 2.75 pounds of nitrogen, phosphoric acid, potash, lime, and magnesia per acre, while a crop of ten bushels of wheat per acre removes 32.36 pounds of the same elements of plant food. Inasmuch as this crop takes so little plant food from the soil, the cotton farmer has

no excuse for allowing his land to decrease in productiveness. Two things will keep his land in bounteous harvest condition: first, let him return the seeds in some form to the land, or, what is better, feed the ground seeds to cattle, make a profit from the cattle, and return manure to the land in place of the seeds; second, at the last working, let him sow some crop like crimson clover or rye in

FIG. 147. WEIGHING

the cotton rows to protect the soil during the winter and to leave humus in the ground for the spring.

The stable manure, if that is used, should be broadcasted over the fields at the rate of six to ten tons an acre. If commercial fertilizers are used, it is best to make two applications. To give the young plants a good start, put about two hundred pounds to the acre in the drill just before planting. Then when the plants are about twelve

or fifteen inches tall, broadcast one hundred or two hundred pounds to the acre.

Relation of Stock to the Cotton Crop. On many farms much of the money for which the cotton is sold in the fall has to go to pay for the commercial fertilizer used in growing the crop. Should not this fact suggest efforts to raise just as good crops without having to buy so much fertilizer? Is there any way by which this can be done? The following suggestions may be helpful. Raise enough stock

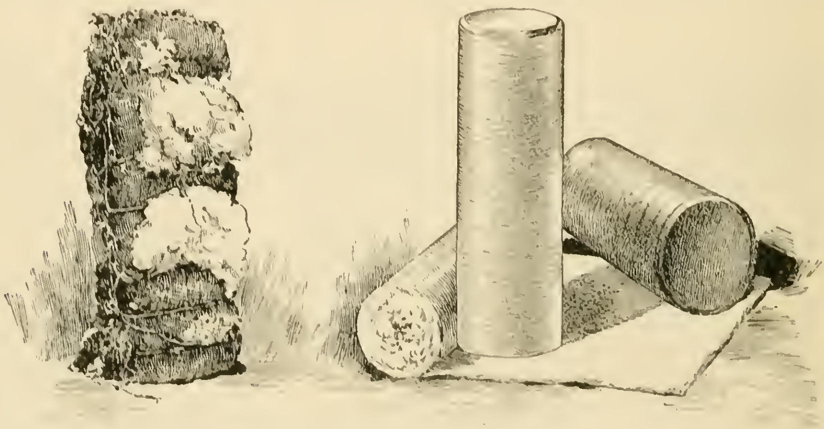


FIG. 148. THE OLD AND THE NEW BALE

to use all the cotton seed grown on the farm. To go with the food made from the seed, grow on the farm pea-vine hay, clover, alfalfa, and other nitrogen-gathering crops. This can be done with small cost. What will be the result?

First, to say nothing of the money made from the cattle, the large quantity of stable manure saved will largely reduce the amount of commercial fertilizer needed. The cotton farmer cannot afford to neglect cattle raising. The cattle sections of the country are making the greatest progress in agriculture.

Second, the nitrogen-gathering crops, while helping to feed the stock, also reduce the fertilizer bills by supplying one of the costly elements of the fertilizer. The ordinary cotton fertilizer consists principally of nitrogen, potash, and phosphoric acid. Of these three, by far the most costly is nitrogen. Now peas, beans, clover, and peanuts will leave enough nitrogen in the soil for cotton. Then, if they be raised, it is necessary to buy only potash and phosphoric acid. This is a very great saving.

SECTION XXXIII — TOBACCO

Fig. 149. A Leaf

The tobacco plant connects Indian agriculture with our own. It has always been a source of great profit to our people. In the early colonial days tobacco was almost exclusively our money crop. Many rich men came to America in those days merely to raise tobacco.

Although tobacco will grow in almost any climate, the leaves, which, as most of you know, are the salable part of the plant, get their desirable or undesirable qualities very largely from the soil, and from the climate in which they grow.

Excepting perhaps the grape, there is no other plant that is so much influenced by its surroundings as tobacco. Since this is true, it follows that tobacco growers must, with this crop more than with any other crop, study the peculiarities of their land.

The soil most acceptable to tobacco is one having the following characteristics: dryness, warmth, richness, depth, and sandiness.

Since tobacco is an exhaustive crop, the greatest attention must be given to keeping up the soil on which it is grown. Occasional crop rotation, and manures are absolutely necessary for keeping up the fertility in tobacco soils.

Fig. 150. A Promising Crop

Commercial fertilizers also are well-nigh a necessity, for, as tobacco land is limited in area, the same land must be often planted in tobacco. Hence even a fresh, rich soil that did not at first require fertilizing soon becomes exhausted and robbed of its plant food by too many crops being grown upon it without rotation, and frequent application of fertilizers and manures is therefore necessary.

Deep plowing, from nine to thirteen inches, is also a prime necessity, for tobacco roots go deep into the soil. After this deep plowing, harrow until the soil is thoroughly pulverized, and is as fine and mellow as that of the flower garden.

Unlike most other farm crops, the tobacco plant must be started first in a seed bed. To prepare a tobacco bed, the almost universal custom is to proceed as follows. Carefully select a protected spot. Over this spot pile brushwood and then burn it. The soil underneath the burned brushwood will be left dry to a depth of several inches. It is then carefully raked and smoothed and planted. A tablespoonful of seed will sow a patch twenty-five feet square. If the seeds come up well, a patch of this size ought to furnish transplants for five or six acres. In sowing, it is not wise to cover the seed deeply. A light raking in or an even rolling of the ground is all that is needed.

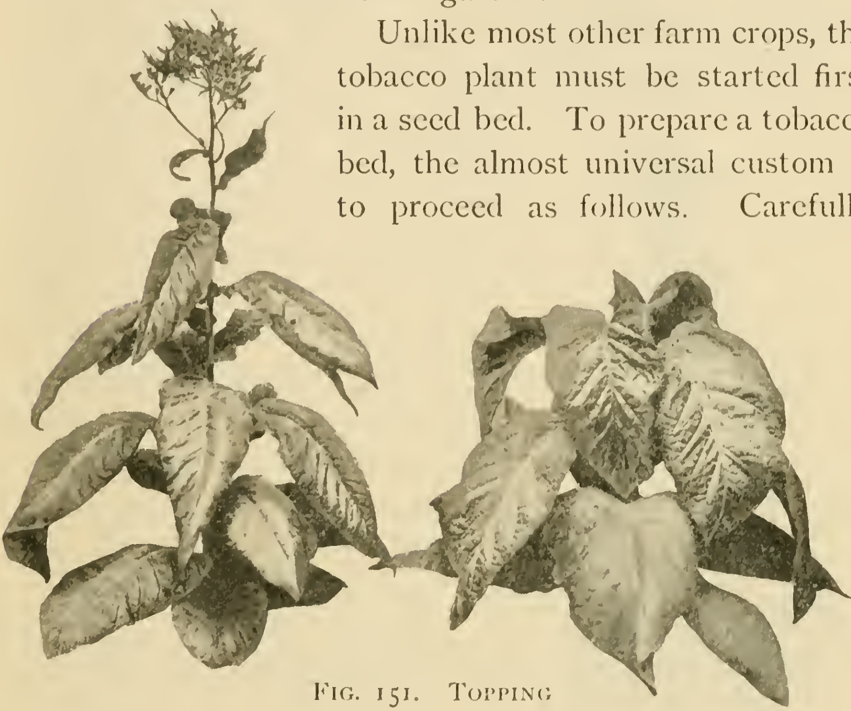


Fig. 151. Topping

The time required for sprouting is from two to three weeks. The plants ought to be ready for transplanting in from four to six weeks. Weeds and grass should of course be kept out of the seed bed.

The plants, when ready, are transplanted very much as cabbages and tomatoes are transplanted. The rows should be from three to four feet apart, and the plants in the rows about two or three feet apart. If the plants are set so that the plow and cultivator can be run with the rows and also across the rows, they can be more economically worked. Tobacco, like corn, requires shallow cultivation. Of course the plants should be worked often enough to give clean culture and to provide a soil mulch for saving moisture.

Fig. 152. A Hand

In tobacco culture it is necessary to pinch off the "buttons" or to cut off the tops of the main stalk, else much nourishment will be given to the seeds that should go to the leaves. The suckers must also be cut off for the same reason.

The proper time for harvesting is not easily fixed; one becomes skillful in this work only through experience in the field. Briefly, we may say that tobacco is ready to be cut when the leaves on being held up to the sun show a light or golden color, when they are sticky to the touch, and are easily broken when bent. Plants that are overripe are inferior to those that are cut early.

The operations included in cutting, housing, drying, shipping, sweating, and packing require skill and practice. The important varieties are as follows:

1. White Burley.
2. Prince Bismarck.
3. General Grant.
4. Yellow Orinoco.
5. Havana.
6. Sumatra.
7. Connecticut Seed Leaf.
8. Hyco.
9. Havana Seed.
10. Pryor.
11. Perique.

SECTION XXXIV — WHEAT

Wheat has been cultivated from earliest times. It was a chief crop in Egypt and Palestine, and still holds its importance in the temperate portions of Europe, Asia, Africa, Australia, and America.

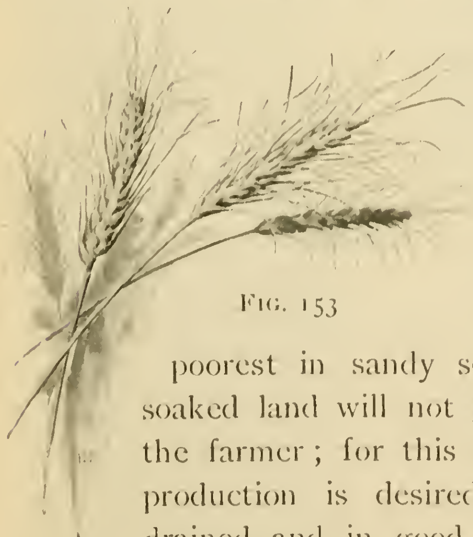


FIG. 153

This crop ranks third in value in the United States. It grows in cool, temperate, and warm climates, and in many kinds of soil. It does best in clay loam, and poorest in sandy soils. Clogged and water-soaked land will not grow wheat with profit to the farmer; for this reason, where good wheat production is desired, the soil must be well drained and in good physical condition, — that is, the soil must be open, crumbly, and mellow.

Clay soils that are hard and lifeless can be made valuable for wheat production by covering the surface with manure,

by good tillage, and by a thorough system of crop rotation. Cowpeas make a most valuable crop to precede wheat, for in growing they add atmospheric nitrogen to the soil; their roots loosen the root bed, thereby admitting a free circulation of air, and adding humus to the soil. Moreover, the cowpea leaves the soil in the compact condition so much desired in wheat production.

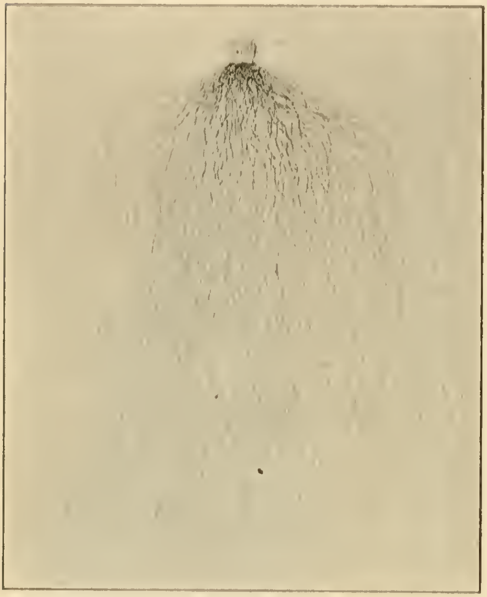


Fig. 154. Roots of a Single Wheat Plant

One may secure a good seed bed after cotton and corn as well as after peas. They are summer-cultivated crops, and the clean culture that has been given them renders the surface soil mellow and the undersoil firm and compact. They are not so good, however, as cowpeas, since they add no atmospheric nitrogen to the soil, as all leguminous crops do.

From one to two inches is the most satisfactory depth for planting wheat. The largest number of seeds comes up when planted at this depth. A mellow soil is very helpful to good coming up and provides a most comfortable home for the roots of the plant. A compact soil below makes a moist undersoil; and this is desirable, for the soil water is needed to dissolve plant food and to carry it up through the plant, where it is used in building tissue.

Fig. 155. Adjoining Wheat Fields

The yield of the lower field, forty-five bushels per acre, is due to intelligent farming

There are a great many varieties of wheat: some are bearded, others are smooth; some are winter and others are spring varieties. The smooth-headed varieties are most agreeable to handle during harvest and at threshing time. Some of the bearded varieties, however, do so well in some soils and climates that it is desirable to continue growing them, though they are less agreeable to handle.

FIG. 156. SELECTING SEED

No matter what variety you are accustomed to raise, it may be improved by careful seed selection.

The seed drill is the best implement for planting wheat. It distributes the grains evenly over the whole field and leaves the mellow soil in a condition to catch what snow may fall and secure what protection it affords.

In many parts of the country, because so little live stock is raised, there is often too little manure to apply to the wheat land. Where this is the case, commercial fertilizers

must be used. Since soils differ greatly, it is impossible to suggest a fertilizer adapted to all soils. The elements usually lacking in wheat soils are nitrogen, phosphoric acid, and potash.

The land may be lacking in one or all of these plant foods; if this is so, a maximum crop cannot possibly be raised. The section discussing manuring the soil will be helpful to the wheat grower.

It should be remembered always in buying fertilizers for wheat that whenever wheat follows cowpeas there is no

Fig. 157. A Bountiful Harvest

need of using nitrogen in the fertilizer; the tubercles on the pea roots will furnish that. Hence only potash and phosphoric acid will have to be purchased as plant food.

The farmer is assisted always by a study of his crop and by a knowledge of how it grows. If he find the straw inferior and short, it means that the soil is deficient in nitrogen; but, on the other hand, if the straw be luxuriant and the heads small and poorly filled, he may be sure that his soil contains too little phosphoric acid and potash.

EXERCISE

Let the pupils secure several heads of wheat and thresh each separately by hand. The grains should then be counted and their plumpness and size observed. The practical importance of this is obvious, for the larger the heads and the greater the number of grains, the larger the yield per acre. Let them plant some of the large and some of the small grains. A single test of this kind will show the importance of careful seed selection.

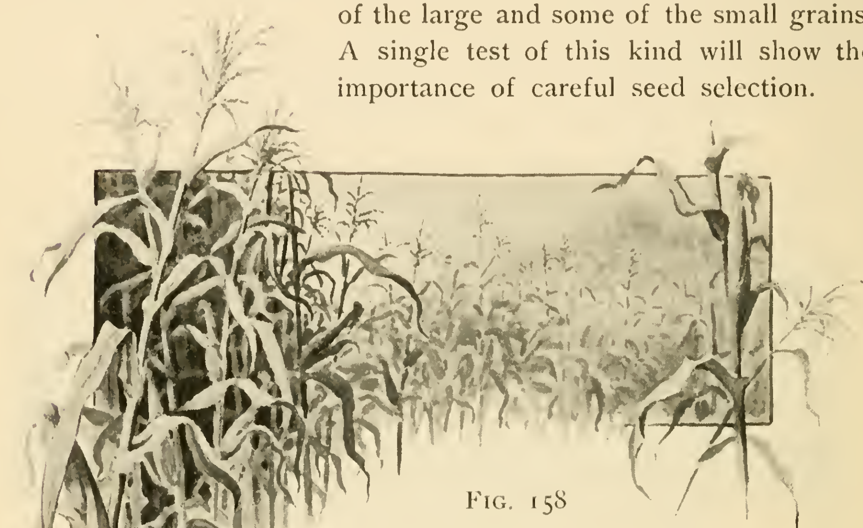


Fig. 158

SECTION XXXV — CORN

When the white man came to this country, he found the Indian using corn; for this reason it, in addition to its name *maize*, is called *Indian corn.* Before that time the civilized world did not know that there was such a crop. The increase in the yield and the extension of the acres planted in this strictly American crop have kept pace with the rapid and wonderful growth of our country. Corn is king of the cereals, and the most

important crop of American agriculture. It is the backbone of farming in this country. Live stock of every kind are fed upon rations into which it largely enters, and it feeds more human beings than any other grain except perhaps rice. It grows in almost every section of America.

A soil rich in both decaying animal and vegetable matter, loose, warm, and moist but not wet, will produce a better crop of corn than any other. Corn soil should always be well tilled and cultivated.

The proper time to begin the cultivation of corn is before it is planted. Plow deeply. A shallow, worn-out soil should not be used for corn, but for cowpeas. After thorough and deep plowing, the harrow — either the disk or spring tooth — should be used to destroy all clods and leave the surface mellow and fine. The best results will be obtained by "turning under" a clover sod that has been manured from the savings of the barnyard.

When manure is not available, commercial fertilizers will often prove profitable on poor lands. No one but the farmer himself is able to say how much fertilizer an acre is necessary or what kinds are to be used. A little study and experimenting on his part will soon enable him to find out both the kind and the amount of fertilizer that is best suited to his land.

The seed for this crop should be selected according to the plan suggested in another section of this book.

The most economical method of planting is by means of the horse planter, which, according to its adjustment, plants regularly in hills or in drills.

A few days after planting, the cornfield should be harrowed with a fine-tooth harrow to loosen the top soil and

to kill the grass and the weed seeds that are germinating at the surface. When the corn plants are from a half inch to an inch high, the harrow should again be used. A little work at this stage will save many days of labor during the rest of the season.

Corn is a crop that needs constant cultivation, and during the growing season the soil should be stirred at least four times. This cultivation is for three reasons:

1. To destroy weeds that would take plant food and water.

2. To provide a mulch of dry soil so as to prevent the evaporation of moisture. The action of this mulch has already been explained.

3. Because "tillage is manure." Constant stirring of the soil allows the air to circulate, provides a more effective mulch, and changes unavailable plant food into the form that plants use.

Deep culture of corn is not advisable. The roots in their early stages of growth are shallow feeders and spread all over the ground only a few inches below the surface. The cultivation that destroys or disturbs the roots injures the plants and lessens the yield. We cultivate because of the three reasons given above, and not to stir the soil about the roots or to loosen it there.

In many parts of the country, the cornstalks are left standing in the fields or are burned. This is a great mistake, for the stalks are worth a great deal for feeding horses, cattle, and sheep. These stalks ought always to be saved by the use of the husker and shredder. Corn after being matured and cut ought to be put in shocks and left thus until dry enough to run through the husker and

FIG. 159. CORN SHOCKED FOR THE SHREDDER

shredder. This machine separates the corn from the stalk and husks it. At the same time it shreds tops, leaves, and butts into a food that is both nutritious and palatable to

Fig. 160. The Difference is due to Tillage

From *Review of Reviews*

stock. Almost as much feeding value is obtained from corn stover treated in this way as from timothy hay. The practice of not using the stalks is wasteful and is fast being

abandoned. The only reason that so much good food is being left to decay in the field is because so many people are ignorant of the feeding value of this stover.

EXPERIMENT

To show the effect of cultivation on the yield of corn, let the pupils lay off five plats in some convenient field. Each plat need consist of only two rows about twenty feet long. Treat each plat as follows:

Plat 1. No cultivation: let weeds grow.

Plat 2. Mulch with straw.

Plat 3. Shallow cultivation: not deeper than two inches and at least five times during the growing season.

Plat 4. Deep cultivation: at least four inches deep, so as to injure and tear out some of the roots (this is a common method).

Plat 5. Root pruning: ten inches from the stalk and six inches deep, prune the roots with a long knife. Cultivate five times during the season.

FIG. 161

Observe plats during summer, and at husking time note results.

SECTION XXXVI — PEANUTS

This plant is rich in names; the terms *ground pea*, *goober*, *earthnut*, and *pindar*, as well as the more general name of *peanut*, being applied to it locally. The peanut is a true legume, and, like other legumes, bears nitrogen-gathering tubercles upon its roots. The fruit, not a real nut but rather a kind of pea or bean, develops from the

blossom. After the fall of the blossom, the "spike," or flower stalk, pushes its way into the ground, where the nut develops. If unable to penetrate the soil, the nut dies.

In the United States, North and South Carolina, Virginia, and Tennessee have the most favorable climates for peanut culture. Suitable climate and soil, however, obtain

FIG. 162. A GOOD SHOCK

from New Jersey to the Mississippi valley. A high, porous, sandy loam is the most suitable. Stiffer soils, while yielding better, injure the color of the nut. Lime is a requisite, and must be supplied if the soil is deficient. Phosphoric acid and potash are needed.

Greater care than is usually bestowed should be given to the selection of the peanut seed. In addition to following

out the principles given in Section XVIII, all musty, defective seeds must be discarded and all frosted kernels must be rejected. Before it dries, the peanut seed is easily injured by frost. The slightest frost on the vines, either before or after the vine is dug, does much harm to the tender seed.

In growing peanuts, thorough preparation of the soil is much better than later cultivation. Destroy the crop of young weeds, but do not disturb the peanut crop by late cultivation.

Harvest before frost, and shock high to keep the vines from the ground.

The average yield of peanuts in the United States is seventeen bushels an acre. In Virginia the yield is twenty bushels an acre and in Tennessee it reaches thirty-two bushels an acre.

SECTION XXXVII — SWEET POTATOES

The roots of sweet potatoes are put upon the market in various forms. Aside from the form in which they are ordinarily sold, some potatoes are dried and then ground into flour, some are canned, some are used to make starch, some furnish a kind of sugar called glucose, and some are even used to make alcohol.

The fact that there are over eighty varieties of potatoes shows the popularity of the plant. Now it is evident that all of these varieties cannot be equally desirable. Hence the wise grower will select his varieties with prudent forethought. Efforts should be made, as described in Section XVIII, to improve every variety selected.

Four months of mild weather, months free from frost and cold winds, are necessary for the growing of sweet potatoes. In a mild climate, almost any loose, well-drained soil will produce them. A light, sandy loam, however, gives a cleaner potato, and one therefore that sells better.

The sweet potato draws potash, nitrogen, and phosphoric acid from the soil, but in applying these as fertilizers the planter must study and know his own soil. If he does not, he may waste both money and plant food by the addition of elements already present in sufficient quantity in the soil. The only way to come to reliable conclusions as to the needs of the soil is to try two or three different kinds of fertilizers on plats of the same soil, during the same season, and notice the resulting crop of potatoes.

The sweet potato does not require deep plowing. Deep plowing is even a disadvantage. Nor does it matter much what crop precedes sweet potatoes. However, potatoes should not follow a sod. This is because sods are often thick with cutworms, one of the serious enemies of the potato.

It is needless to say that the crops must be kept clean by thorough cultivation until the vines take full possession of the field.

In harvesting, extreme care should be used to avoid cutting and bruising the potato, since bruises are as dangerous to a sweet potato as to an apple, and render decay almost a certainty. Lay aside all bruised potatoes for immediate use.

For shipment the potatoes should be graded and packed with care. An extra outlay of fifty cents a barrel often brings a return of one dollar a barrel in the market. One

fact often neglected by Southern growers who raise for a Northern market is that the Northern markets demand a potato that will cook dry and mealy, and that they will not accept the juicy, sugary potato so popular in the South.

The storage of sweet potatoes presents difficulties, owing to their great tendency to decay under the influence of the ever-present fungi and bacteria. This tendency can be met by preventing bruises and by keeping the bin free from rotting potatoes. The potatoes should be partly dried and cleaned and then stored in a dry, warm place.

The sweet potato vine makes a fair quality of hay, and with proper precaution may be used for ensilage. Small, defective, unsalable potatoes are rich in sugar and starch, and are therefore good stock food. Since they contain such a large per cent of water, they cannot be regarded as a concentrated food, and must be used only as an aid to other diet.

SECTION XXXVIII — RICE

The United States produce only about one half of the rice that this country consumes. There is no satisfactory reason for our not raising more of this staple crop, for five great states along the Gulf of Mexico are well adapted to its culture.

There are two distinct kinds of rice, upland rice and lowland rice. Upland rice demands in general the same methods of culture that are required by other cereals, as, for example, oats or wheat. The growing of lowland rice is more complicated, involving the necessity of flooding the fields at proper times with water. This is a much too difficult subject to enter upon here.

A stiff, half-clay soil with some loam is best suited to this crop. The soil should have a clay subsoil to retain water and to give stiffness enough to allow the use of harvesting machinery. Some good rice soils are so stiff that they must be flooded to soften them enough to admit of plowing. Plow deeply to give the roots ample feeding space. Good tillage, which is too often neglected, is valuable.

Careful seed selection is perhaps even more needed for rice than for any other crop. Uniformity of kernel is demanded. Be sure that your seed is free from red rice and other weeds. Drilling is much better than broadcasting, as it secures more even distribution.

The notion generally prevails that flooding returns to the soil the needed fertility. This may be true if the flooding water deposits much silt, but if the water be clear it is untrue, and fertilizers or leguminous crops are needed to keep up fertility. Cowpeas replace the lost soil elements and keep down weeds, grasses, and red rice.

Red rice is a weed close kin to rice, but the seed of one will not produce the other. Do not allow it to get mixed and sowed with your rice seed, or to go to seed in your field.

Write to the Department of Agriculture for the following bulletins:

Division of Botany, Bulletin 22.
Division of Statistics, Miscellaneous Series, Report 6.
Office of Experiment Stations, Bulletin 113.
Farmers' Bulletin 110.

SECTION XXXIX — THE FARM GARDEN

Every farmer should have a garden in which he should grow not only the vegetables needed for the home table, but also all the small fruits.

The garden should always be within convenient distance of the farmhouse. If possible, the spot selected should have a soil of mixed loam and clay. Every foot of soil in the garden should be made rich and mellow by manure and cultivation. The worst soils for the home garden are light, sandy soils, or stiff, clayey soils; but any soil, by judicious and intelligent culture, can be made suitable.

In laying out the garden we should bear in mind that hand labor is the most expensive kind of labor. Hence we should not, as is commonly done, lay off the garden spot in the form of a square, but we should mark off for our purpose a long, narrow piece of land, so that the cultivating tools may all be conveniently drawn by a horse or mule. The use of the plow and horse cultivator enables the work of taking care of the garden to be done quickly, easily, and cheaply.

Every vegetable or fruit should be planted in rows, and not in little patches. Beginning with one side of the garden the following plan of arrangement would be simple and complete: two rows to corn for table use; two to cabbages, beets, radishes, and eggplants; two to onions, peas, and beans; two to oyster plants, okra, parsley, and turnips; two to tomatoes; then four on the other side can be used for strawberries, blackberries, raspberries, currants, and gooseberries.

The garden, when so arranged, can be tilled in the spring and tended throughout the growing season with little labor and little loss of time. In return for this odd-hour work, the farmer's family will have throughout the year an abundance of fresh, palatable, and health-giving vegetables and small fruits.

The keynote of successful gardening is to stir the soil. Stir it often with four objects in view:

1. To destroy weeds.
2. To ventilate the soil.
3. To enrich the soil by the action of the air.
4. To retain the moisture by preventing its evaporation.

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<tr><td>onions</td><td colspan="3">peas</td><td colspan="2">beans</td></tr>
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FIG. 163. HOW TO LAY OUT THE GARDEN

This illustration shows that practically every garden vegetable and all the small fruits can be included in the farm garden, and all the work be done by horse-drawn tools.

FIG. 164. IN THE SHADE OF THE TREES

CHAPTER VIII

DOMESTIC ANIMALS

The progress that a nation is making can with reasonable accuracy be measured by the kind of live stock it raises. The general rule is, poor stock, poor people. All the prosperous nations of the globe, especially the grain-growing nations, get a large share of their wealth by raising improved stock. The stock bred by these nations is now, however, very different from the stock raised by the same nations years ago. As soon as man began to progress in the art of agriculture he became dissatisfied with inferior stock. He therefore bent his energies to raise the standard of excellence in domestic animals.

By slow stages of animal improvement the angular, thin-flanked wild boar of early times has been transformed into the sleek Berkshire or the well-rounded Poland-China. In the same manner the wild sheep of the Old World have been developed into wool and mutton breeds of the finest excellence. By constant care, attention, and selection, the thin, leggy wild ox has been bred into bounteous milk-producing Jerseys and Holsteins or into Shorthorn mountains of flesh. From the small, bony, coarse and shaggy horse of ancient times has descended the ponderous Norman draft horse and the fleet Arab courser.

The matter of meat production is one of vital importance to man, for animal food must always supply a large part of man's ration.

Live stock of various kinds consume the coarser foods, like the grasses, hays, and grains, which man cannot use. As a result of this consumption they store in their bodies the exact substances required for the building up of the tissues of man's body.

When the animal is used by man for food, one class of foods stored away in the animal body produces muscle; another produces fat, heat, and energy. The food furnished by the slaughter of animals seems necessary to the full development of man. It is true that the flesh of an animal will not support human life as long as would the grain that the animal ate while growing, but it is also true that animal food does not require so much of man's force to digest it. Hence by the use of meat a part of man's life struggle is forced upon the lower animal.

When men feed grain to stock, they receive in return power and food in their most available forms. Men strengthen the animal that they themselves may be strengthened. One of the great questions, then, for the stock grower's consideration is how to make the least amount of food fed to animals produce the most power and flesh.

SECTION XI — HORSES

While we have a great many kinds of horses in America, horses are not natives of this country. Just where wild horses were first tamed and used is not definitely known. It is believed that they were first used for warfare and then gradually bred and adapted to other purposes.

Where food was abundant and nutritious and climate mild and healthful, the early horses developed large frames

and heavy limbs and muscles; on the other hand, where food was scarce and climate cold and bleak, the animals became as dwarfed as the ponies of the Shetland Islands.

One of the first recorded uses of the horse is found in Genesis, chapter xlix, verse 17, where Jacob speaks of "an adder that biteth the horse heels." Pharaoh took

FIG. 165. THE FAMILY PET

"six hundred chosen chariots" and "with all the horses and chariots" pursued the Israelites. The Greeks at first drove the horse fastened to a rude chariot, and later found that they could manage the animal while on its back, with voice or switch and without either saddle or bridle. This ingenious people soon invented the snaffle bit, and both rode and drove with its aid. The curb bit was a Roman invention. Shoeing was not practiced by either Greek or

Roman. Saddles and harnesses were at first made of skins and sometimes of cloth.

Among the Tartars of middle and northern Asia, and also among some other nations, mare's milk and the flesh of the horse are used for food. Old and otherwise worthless horses are regularly fattened for the meat markets of France

Fig. 166. Percheron Horse (the Draft Type)

and Germany. Various uses are made of the different parts of a horse's body. The mane and tail are used in the manufacture of mattresses, and the same parts furnish a haircloth for upholstering; the skin is tanned into leather; the hoofs are used for glue, and the bones for making fertilizer.

Climate, food, and natural surroundings have all aided in producing changes in the horse's form, size, and appearance.

The varying circumstances under which horses have been raised have originated the different breeds. In addition, the master's selection had much to do in developing the type of horses wanted : some desired work horses, and they

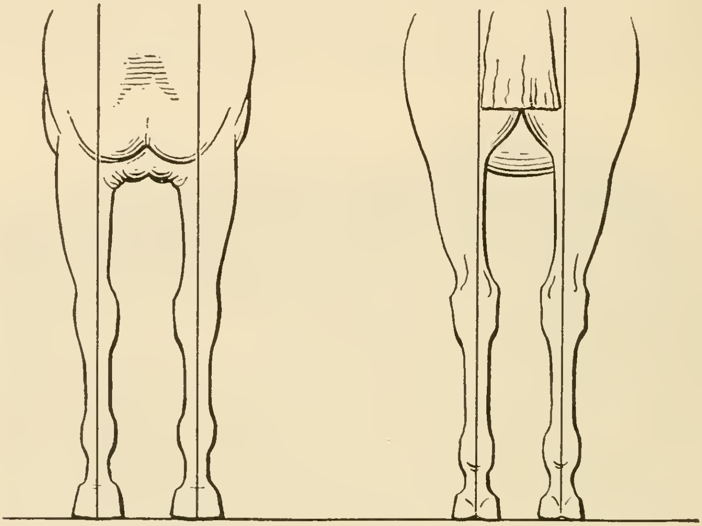

Fig. 167

Diagram shows the proper shape of the fore and hind legs of a horse. When the straight lines divide the legs equally, the leg action is straight and regular

kept the heavy, muscular, stout-limbed animals ; others desired riding and driving horses, so they saved for their use the light-limbed, angular horses that had endurance and stamina. The following table gives some of the different breeds and the places of their development :

I. *Draft, or Heavy, Breeds*

1. Percheron, from the province of Perche in France.
2. French Draft, developed in France.
3. Belgian Draft, developed by Belgian farmers.
4. Clydesdale, the draft horse of Scotland.
5. Suffolk Punch, from the eastern part of England.
6. English Shire, also from the eastern part of England.

II. *Carriage, or Coach, Breeds*

1. Cleveland Bay, developed in England.
2. French Coach, the gentleman's horse of France.
3. German Coach, from Germany.
4. Oldenburg Coach, Oldenburg, Germany.
5. Hackney, the English high-stepper.

III. *Light, or Roadster, Breeds*

1. American Trotter, developed in America.
2. The Thoroughbred, the English running horse.
3. The American Saddle Horse, from Kentucky and Virginia.

There is a marked difference in the form and type of these horses, and on this difference their usefulness depends.

The draft breeds have short legs, and hence their bodies are comparatively close to the ground. The depth

FIG. 168. WIDE HOCK

This horse stands great strains and is not fatigued easily

FIG. 169. NARROW HOCK

This horse becomes exhausted very easily

of the body should be about the same as the length of leg. All draft horses should have upright shoulders, so as to provide an easy support for the collar. The hock should be wide, so that the animal shall have great leverage of

muscle for pulling. A horse having a narrow hock is not able to draw a heavy load, is easily exhausted, and liable to curb diseases (see Figs. 168 and 169).

The legs of all kinds of horses should be straight: a line dropped from the point of the shoulder to the ground should divide the knees, canon, fetlock, and foot in two equal parts. When the animal is formed in this way, the

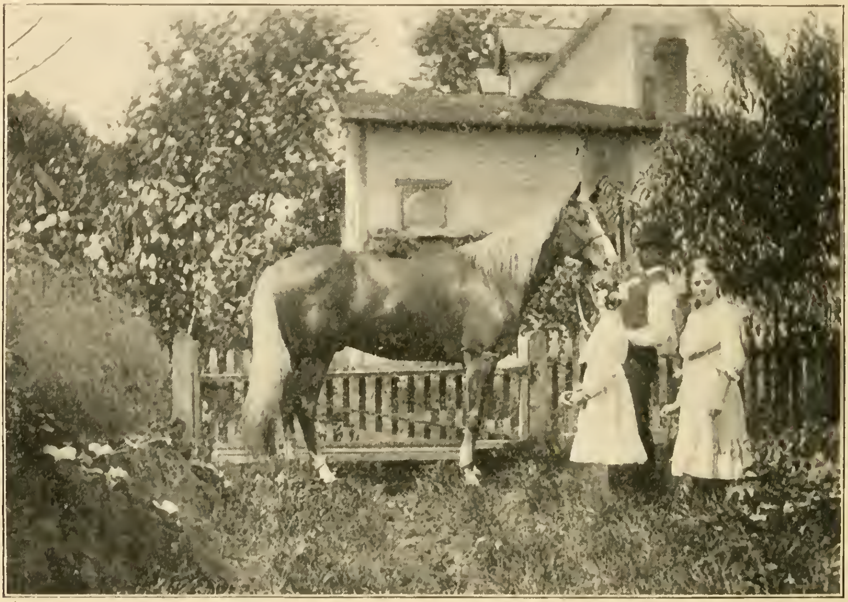

FIG. 170. THE ROADSTER TYPE

feet have room to be straight and square, with just the breadth of a hoof between them (Fig. 167).

The roadsters are lighter in bone and less heavily muscled; their legs are longer than those of the draft horses, and, as horsemen say, more "daylight" can be seen under the body. The neck is long and thin, but fits nicely into the shoulders. The shoulders are sloping and long, and give the roadster ability to reach well out in his stride. The

head is set gracefully on the neck, and should be carried with ease and erectness.

Every man who is to deal with horses ought to become, by observation and study, an expert judge of forms, qualities, types, defects, and excellences.

The horse's foot makes an interesting study. The horny outside protects the foot from mud, ice, and stones. Inside

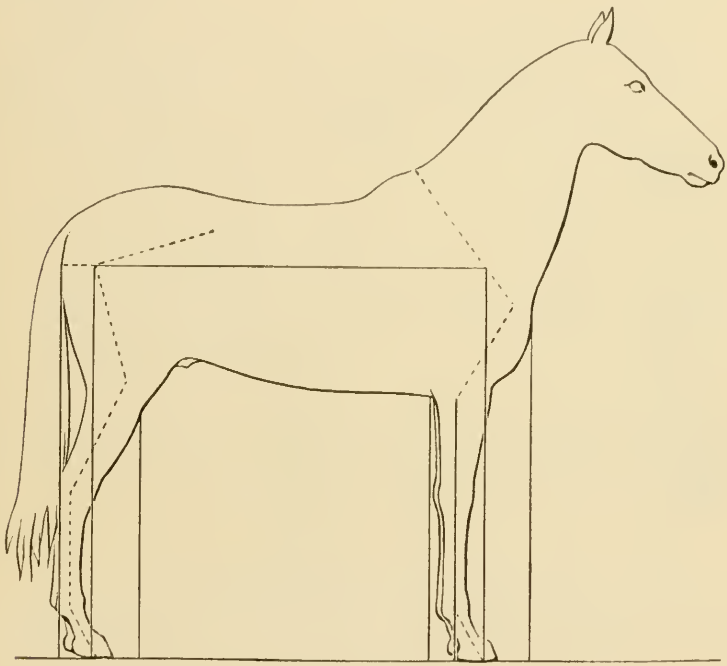

FIG. 171. SIDE VIEW OF LEGS

The diagram shows how the straight lines ought to cross the legs of a properly shaped horse

the hoof are the bones and gristle that serve as cushions to diminish the shock received while walking or running on hard roads or streets. When shoeing the horse, the frog should not be touched with the knife. It is very seldom

that any cutting need be done. Many blacksmiths do not know this, and often greatly injure the foot.

Since the horse has but a small stomach, the food given the animal should not be too bulky. In proportion to its size, its grain ration should be larger than that of other animals. Draft horses and mules, however, can be fed

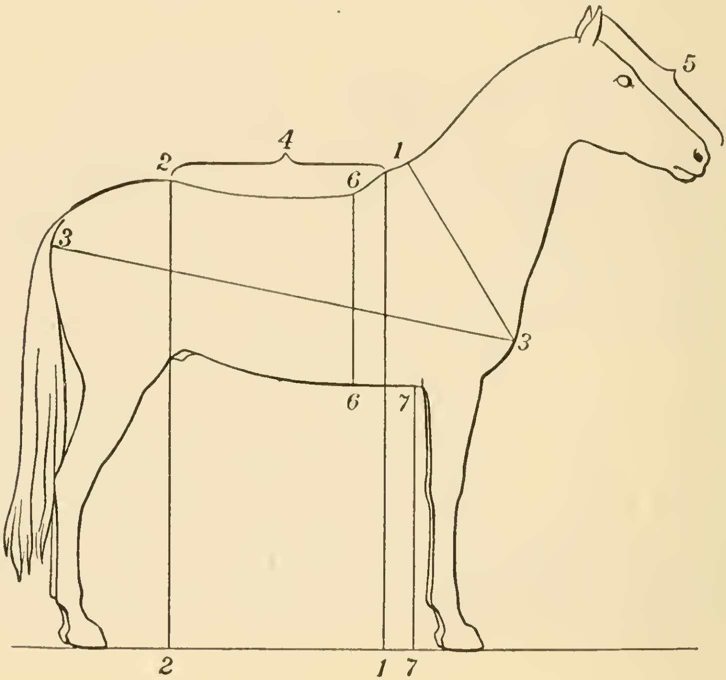

FIG. 172. HOW TO MEASURE A HORSE

a more bulky ration than other horses, because they have larger stomachs and hence greater storage capacity.

The horse should be groomed every day. This keeps the pores of the skin open and the hair bright and glossy. When horses are working hard, the harness should be removed during the noon hour. During the cool seasons of the year, whenever a horse is wet with perspiration, it

should on stopping work, or when standing for a while, be blanketed; for the animal is as liable as man to get cold in a draught, or from too rapid evaporation.

EXERCISE

If the pupil will take an ordinary tape measure, he can make some measurements of the horse that will be very interesting as well as profitable. Let him measure:

1. The height of the horse at the withers, 1 to 1.
2. The height of the horse at croup, 2 to 2.
3. Length of shoulder, 1 to 3.
4. Length of back, 4.
5. Length of head, 5.
6. Depth of body, 6 to 6.
7. Daylight under body, 7 to 7.
8. Distance from point of shoulder to quarter, 3 to 3.
9. Width of forehead.
10. Width between hips.

NOTE. Many interesting comparisons can be made (1) by measuring several horses, (2) by studying the proportion between parts of the same horse.

Proportions of a Horse

1. How many times longer is the body than the head? Do you get the same result from different horses?

2. How does the height at the withers compare with the height at croup?

3. How do these compare with distance from quarter to shoulder?

4. How does the length of head compare with thickness of body, and the open space, or "daylight," under the body?

SECTION XLI — CATTLE

All farm animals were once called *cattle;* now this term applies only to beef and dairy animals, — neat cattle.

Our improved breeds are descended from the wild ox of Europe and Asia, and have attained their size and usefulness by care, food, and selection. The uses of cattle are so familiar that we need scarcely mention them. Their flesh is a part of the daily food of man, — butter, cheese, and milk are on every table; their hides go to make leather, and their hair for plaster; their hoofs for glue; their bones for fertilizers, ornaments, and buttons, and many other purposes.

FIG. 173. A PRIZE WINNER

There are two main classes of cattle, — beef breeds and dairy breeds. The principal breeds of each class are as follows:

I. *Beef Breeds*

1. Aberdeen-Angus, bred in Scotland, and often called *doddies.*
2. Galloways, from Scotland.
3. Shorthorn, or Durham, an English breed of cattle.
4. Hereford, also an English breed.
5. Sussex, from the county of Sussex, England.

II. *Dairy Breeds*

1. Jersey, from the Isle of Jersey.
2. Guernsey, from the Isle of Guernsey.
3. Ayrshire, from Scotland.
4. Holstein-Frisian, from Holland and Denmark.
5. Brown Swiss, from Switzerland.

Other breeds of cattle are Devon, Dutch-Belted, Red-Polled, Kerry, American Holderness, and West Highland.

In general structure there is a marked difference between the beef and dairy breeds. This is shown in Figs. 174, 175.

FIG. 174. ABERDEEN-ANGUS COW (A BEEF TYPE)

The beef cow is square, full over the back and loins, and straight in the back. The hips are evenly fleshed, the legs full and thick, the under line, or stomach line, parallel

to the back line, and the neck full and short. The eye should be bright, the face short, the bones of fine texture, and the skin soft and pliable.

The dairy cow is altogether different from the beef cow. She shows a decided wedge shape when you look at her from front, side, and rear. The back line is crooked, the hip bones and tail bone are prominent, the thighs thin and

FIG. 175. JERSEY COW (A DAIRY TYPE)

poorly fleshed; there is no breadth to the back, as in the beef cow, and little flesh covers the shoulder; the neck is long and thin.

The udder of the dairy cow is most important. It should be full but not fleshy, well attached behind and extending well forward. The larger the udder, the more milk given.

The skin of the dairy cow should be soft and pliable, and the bones fine textured.

The Dairy Type. Because of lack of flesh on the back, loins, and thighs, the dairy type produces neither good nor profitable meat. This is because in the dairy animal food goes to produce milk rather than beef. In the same way the beef cow gives little milk, since her food goes rather to fat than to milk. For the same reasons that you do not expect a plow horse to win on the race track, you do not expect a cow of the beef type to win premiums as a milker.

FIG. 176. HEAD OF A GALLOWAY COW

"Scrub cattle" are not very profitable. They mature slowly and consequently consume much food before they are able to give any return for it. Even when fattened, the fat and lean portions are not evenly distributed, and "choice cuts" are few and small.

By far the cheapest method of securing a healthy and profitable herd of dairy or beef cattle is to save only the calves whose sires are standard-bred animals and whose mothers are native cows. In this way farmers of even little means can soon build up an excellent herd.

Improving Cattle. The fact that it is not possible for every farmer to possess pure-bred cattle is no reason why he should not improve the stock he has. He can do this

by using pure-bred sires that possess the characteristics desired. Scrub stock can be quickly improved by the continuous use of good sires. It is never wise to use grade or cross-bred sires, since they do not possess stable characters.

Moreover, it is possible for every farmer to determine exactly the producing power of his dairy cows. When the cows are milked, the milk should be weighed and a record kept. If this be done, it will be found that some cows produce as much as four hundred or five hundred gallons a year, while others produce not more than half that quantity. If a farmer kill or sell his poor cows and keep his best ones, he will in a short while have a herd of only heavy milkers. Ask your father to try this plan. Read everything you can find about taking care of cows and improving them, and then start a herd of your own.

Fig. 177. Shorthorn Cow

Conclusions. (1) A cow with a tendency to get fat is not profitable for the dairy. (2) A thin, open, angular cow will make expensive beef. (3) "The sire is half the herd." This means that a good sire is necessary to improve a herd of cattle. The improvement from scrubs upward is as follows: the first generation is one half pure; the second is three fourths pure; the third is seven eighths pure; the

fourth is fifteen sixteenths pure, etc. (4) By keeping a record of the quantity and quality of milk each cow gives you can tell which are profitable to raise from and which are not. (5) Good food, clean water, kindness, and care are necessary to successful cattle growing.

SECTION XLII — SHEEP

The sheep was perhaps the first animal domesticated by man, and to-day the domesticated sheep is found wherever man lives. It is found domesticated or wild in every latitude, and finds sustenance and thrives where other animals

FIG. 178. A YOUNG SHEPHERD

can scarcely live; it provides man with meat and clothing, and is one of the most profitable and easily cared for of animals.

Sheep increase so rapidly, mature at such an early age, and their flesh is so wholesome for food that most farms

Fig. 179. Ready for the Fair

should have their flock. Another consideration that may be urged in favor of sheep raising is that sheep improve the land on which they are pastured.

Sheep are docile, easily handled, live on a greater diversity of food, and require less grain than any other kind of live

FIG. 180. IN THE PASTURE

stock. In mixed farming there is enough food wasted on almost every farm to maintain a small flock of sheep.

Sheep may be divided into three classes:

I. *Fine-Wooled Breeds*
   1. American Merino.
   2. Delaine Merino.
   3. Rambouillets.

II. *Medium-Wooled Breeds*
   1. Southdown.
   2. Shropshire.
   3. Horned Dorset.
   4. Hampshire Down.
   5. Oxford Down.
   6. Cheviot.

III. *Long-Wooled Breeds*
   1. Leicester.
   2. Lincoln.
   3. Cotswold.

The first group is grown principally for wool, and mutton is secondary; in the second, mutton comes first and wool second; while in the third both are important considerations. Wool is nature's protection for the sheep. Have you ever opened the fleece and observed the clean skin in which the fibers grow? These fibers, or hairs, are so roughened that they push all dirt away from the skin towards the outside of the fleece.

Wool is valuable in proportion to the length and evenness of the fiber and the density of the fleece.

QUESTIONS

1. How many pounds ought a fleece of wool to weigh?
2. Which makes the better clothing, coarse or fine wool?
3. Why are sheep washed before being sheared?
4. Does cold weather trouble sheep? wet weather?

SECTION XLIII — SWINE

The wild boar is a native of Europe, Asia, and Africa. These wild hogs are the parents from which all our domestic

Fig. 181. Which will you raise?

breeds have sprung. In many parts of the world the wild boar is still found. These animals are active and powerful, and as they grow older are fierce and dangerous. In

their wild state they seek moist, sandy, and well-wooded places, close to streams of water. Their favorite foods are fruits, grass, and roots; but when pressed by hunger they will eat snakes, worms, and even higher animals, like birds, fowls, and fish.

Man captured some of these wild animals, fed them abundant and nutritious food, accustomed them to domestic life, selected the best of them to raise from, and in the course

Fig. 182. A Pair of Porkers

of generations developed our present breeds of hogs. The main changes brought about in hogs were these: the legs became shorter, the snout and neck likewise shortened, the shoulders and hams increased their power to take on flesh, and the frame was strengthened to carry the added burden of flesh. In addition, the disposition became more quiet and less roving.

The hog excels all other animals in the cheap production of meat. When it is properly fed and cared for,

it will make the farmer more money in proportion to cost than any other animal on the farm.

The most profitable type of hog has short legs, small bones, straight back and under line, heavy hams, small well-dished head, and heavy shoulders. The scrub and "razor-back" hogs are very unprofitable, and consume an undue amount of food to produce a pound of gain. It requires two years to get the scrub to weigh what a well-bred pig will

Fig. 183. A Good Type

weigh when nine months old. Scrub hogs can be quickly changed in form and type by the use of a pure-bred sire.

A boy whose parents were too poor to send him to college once decided to make his own money and get an education. He bought a sow, and began to raise pigs. He earned the food for both mother and pigs. His hogs increased so rapidly that he had to work hard to keep them in food. By saving the money he received from the sale of his hogs he had enough to keep him two years in college. Suppose you try his plan, and let the hog show you how fast it can make money.

We have several breeds of swine. The important ones are:

I. *Large Breeds*
   1. Chester White.
   2. Improved Yorkshire.
   3. Tamworth.

II. *Medium Breeds*
   1. Berkshire.
   2. Poland-China.
   3. Duroc-Jersey.
   4. Cheshire.

III. *Small Breeds*
   1. Victoria.
   2. Suffolk.
   3. Essex.
   4. Small Yorkshire.

Hogs will be most successfully raised when kept as little as possible in pens. They like the fields and the pasture grass, the open air and the sunshine. Almost any kind of food can be given them. Unlike other stock, they will devour greedily and tirelessly the richest feeding stuffs.

The most desirable hog to raise is one that will produce a more or less even mixture of fat and lean. Where only corn is fed, the body becomes very fat and is not so desirable for food as when middlings, tankage, cowpeas, or soja beans are added as a part of the ration.

When hogs are kept in pens, cleanliness is most important to reduce the danger of disease.

FIG. 184

SECTION XLIV — FARM POULTRY

Our geese, ducks, turkeys, and domestic hens are all descendants of wild fowls, and are more or less similar to them in appearance.

The earliest recorded uses of fowls were for food, for fighting, and for sacrifice. Briefly, the domestic fowl has four well-defined uses, — egg production, meat production, feather production, and pest destruction.

FIG. 185. COCK

You already know that nearly every farmer raises a few fowls for the production of his own eggs and meat, and to help with the grocery bill; but you may be surprised to learn that the farmers of the United States got in 1899 $144,286,158 from the sale of eggs alone. A little proper attention would very largely increase the already handsome sum derived from our fowls. They need dry, warm, well-lighted, and tidily-kept houses. They must have, if we want the best returns, an abundant supply of pure water and a variety of nutritious foods. In cold, rainy, or snowy weather they should have a sheltered yard, and in good weather should be allowed a range wide enough to give them exercise. Their bodies and their nests must be protected from vermin.

FIG. 186. BREEDING YARDS

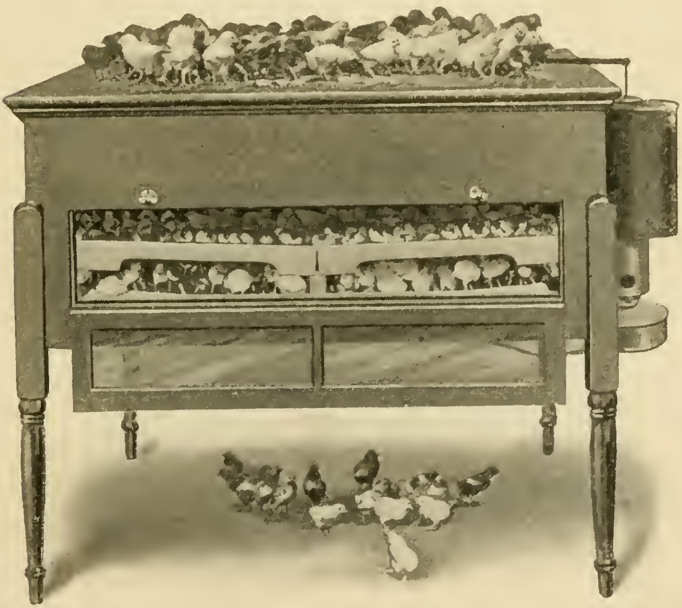

FIG. 187. INCUBATOR

Geese, ducks, and turkeys are not so generally raised as hens, but there is a constant demand at good prices for these fowls.

The varieties of the domestic hen are as follows:

I. *Egg Breeds*

1. Leghorn. 2. Minorca. 3. Spanish. 4. Red Cap.

II. *Meat Breeds*

1. Brahma. 2. Cochin. 3. Langshan.

III. *General Purpose Breeds*

1. Plymouth Rock.
2. Wyandotte.
3. Java.
4. Dominique.
5. Dorking.
6. Indian Game.
7. Rhode Island Red.

IV. *Fancy Breeds*

1. Polish. 2. Game. 3. Sultan. 4. Bantam.

Fig. 188. Brooder

As the price of both eggs and fowls is steadily advancing, a great many people are now raising fowls by means

of an incubator for hatching, and a brooder as a substitute for the mother hen.

The use of the incubator is extending each year and is now almost universal where any considerable number of chicks is to be hatched. The incubator will doubtlessly be used wherever poultry production is engaged in upon a large scale.

The brooder is employed to take care of the chickens as soon as they leave the incubator.

SECTION XLV — BEE CULTURE

Stock raisers select breeds that are best adapted to their needs. Plant growers exercise great care in their choice of plants, selecting for each planting those best suited to the condition in which they are to be grown.

FIG. 189. A CORNIOLAN WORKER

From a drawing furnished by the United States Department of Agriculture

Undoubtedly a larger yield of honey could be had each year if similar care were exercised in the selection of the breed of bees. To prove this, one has only to compare the yield of two different kinds. The common East Indian honeybee rarely produces more than ten to twelve pounds a hive, while the Cyprian bee, which is a most industrious worker, has a record of one thousand pounds in one season from a single colony. This bee, besides being industrious when honey material is plentiful, is also very persevering when such material is hard to find. These

Cyprians have two other very desirable qualities. They stand the cold of winter well, and stoutly defend their hives against robber bees and other enemies.

The Italian is another good bee. This variety was imported into the United States in 1860. While the yield from the Italian is somewhat less than from the Cyprian, the Italian bees produce a whiter comb and are a trifle more manageable.

Fig. 190. A Corniolan Drone

From a drawing furnished by the United States Department of Agriculture

The common black or brown bee is found wild and domesticated throughout the country. When honey material is abundant, these bees equal the Italians in honey production; but, when the season is poor, they fall far short in the amount of honey produced.

The purchase of a good Cyprian or Italian hive will richly repay the buyer. This colony will cost more at the outset than an ordinary colony, but will soon pay for its higher cost by greater production.

A beehive in the spring contains one queen, several hundred drones, and from thirty-five to forty thousand workers. The duty of the queen is to lay all the eggs that are to hatch the future bees. This she does with proverbial industry, often laying as many as four thousand in twenty-four hours.

The workers do all of the work. Some of them visit the flowers, take up the nectar into the honey sac, located in their abdomens, and carry it to the hive. There other workers create a breeze by buzzing with their wings, and produce heat by their activity, — all to cause the water to evaporate from the nectar and to convert it into honey before it is sealed up in the comb. After a big day's gathering you may often hear these tireless workers buzzing till late into the night, or even all through the night.

You know that the bees get nectar from the flowers of various plants. Some of the chief honey plants are alfalfa, buckwheat, horse mint, sourwood, white sage, wild pennyroyal, black gum, holly, chestnut, magnolia, and the tulip, often called the poplar. The yield of honey may often be increased by providing special pasturage for the bees. The linden tree, for example, besides being ornamental and valuable for timber, produces a most bee-inviting flower. Vetch, clover, and most of the legumes and mints are valuable plants to furnish pasture for bees. Catnip may be cultivated for the bees and sold as an herb as well.

Fig. 191. A Corniolan Queen

From a drawing furnished by the United States Department of Agriculture

In spraying fruit trees to prevent disease, you should always avoid spraying when the trees are in bloom, since the poison of the spray seriously endangers the lives of your bees.

The eggs laid by the queen, if they are to produce workers, require about twenty-one days to bring forth the perfect

bee. The newly hatched bee commences life as a nurse. When ten days old, it begins to try its wings in short flights, and in two weeks it begins active work. You may distinguish young exercising bees from real workers by the fact that they do not fly directly away upon emerging from the hive, but circle around a bit in order to make sure that they can recognize home again, since they would receive no cordial welcome if they should attempt to enter another hive. They hesitate upon returning from even these short flights, to make sure that they are in front of their own door.

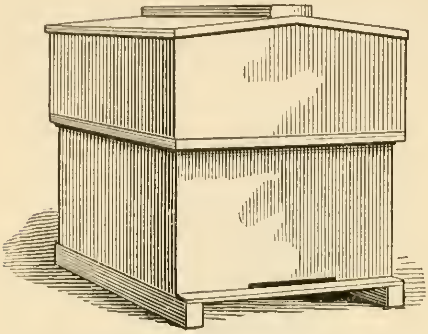

Fig. 192. Good Form of Hive

There are several kinds of enemies of the bee which all bee keepers should know. One of these is the robber bee, that is, a bee from another colony attempting to steal honey from the rightful owners, an attempt often resulting in frightful slaughter. Much robbery can be avoided by clean handling, — that is, by leaving no honey about to cultivate a taste for stolen sweets.

Queenless or otherwise weak colonies should be protected by a narrow entrance that admits only one bee at a time. Such a pass may be easily guarded. Fig. 193 shows a good anti-robbery entrance which may be readily provided for every weak colony. Mice may be

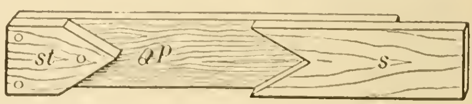

Fig. 193. Anti-Robbing Entrance

st, stationary piece; *s*, slide; *p*, pin, or stop

kept out by tin-lined entrances. The widespread fear of the kingbird seems unfounded. He rarely eats anything but drones, and very few of them. This is also true of the swallow. Toads, lizards, and spiders are, however, true enemies of the honeybee.

EXERCISE

Can you recognize drones, workers, and queens? Do bees usually limit their visits to one kind of blossom on any one trip? What effect has the kind of flower on the flavor of the honey produced? What kind of flowers should the bee keeper provide for his bees? Is the kingbird really an enemy to the bee? Apply to Division of Entomology, Washington, D.C., for Bulletin 1, on the honeybee.

SECTION XLVI — WHY WE FEED

In the first place, we give various kinds of feeding stuffs to our animals that they may live. The heart beats all the time, the lungs contract and expand, digestion is taking place, the blood circulates through the body — something must supply force for these acts or the animal dies. This force is derived from food.

In the next place, food is required to keep the body warm. Food in this respect is fuel, and acts in the same way that wood or coal does in the stove. Our bodies are warm all the time, and they are kept warm by the food we eat at mealtimes.

Then, in the third place, food is required to enable the body to enlarge, to grow. If you feed a colt just enough to keep it alive and warm, there will be no material present to enable it to grow; hence you must add enough food to form bone and flesh and muscle and hair and fat.

In the fourth place, we feed to produce strength for work. An animal poorly fed cannot do so much work at the plow or on the road as one receiving all the food needed.

Both food and the force produced by it result from the activity of plants. By means of sunlight and moisture, a sprouting seed, taking out of the air and soil different elements, grows into a plant. Then, just as the plant feeds upon the air and soil to get its growth, so the animal feeds upon the plant to get its growth. Hence, since our animals feed upon plants, we must find out what is in plants to know what animal food consists of. What, we are now ready to ask, are plants made of?

Chemists have found out that in studying plants there are five important groups of substances to be considered. These are protein, carbohydrates, fat, mineral matter, and water. What is each of these, and what use does the animal make of each?

First, protein, the most important, must be considered. The animal food called by this queer name is not unknown to you. You have all your lives seen it in compounds like the white of an egg, lean meat, or the gluten of wheat. It is made of three gases (oxygen, hydrogen, and nitrogen) and two solid bodies (carbon and sulphur). The bodies of plants do not contain very much protein. Roots, grass, hay, and straw have a very small amount of it. On the other hand, all plant seeds contain a good deal of this substance. What use do the animals make of protein? Animals form their new blood, their muscles, and their lean meat from protein food. It is easy, then, to see the value of protein.

In addition, this substance rebuilds largely the waste of the body. This is harder to understand. Every boy,

perhaps, has made a snow man, and knows that unless he can add new snow regularly, the body of the snow man will soon waste away. All animal bodies are daily using up the materials of the body. If this waste is not made up, the bodies of animals, like the body of the snow man, soon waste away. Now, just as the boy in cold climates supplies new snow to his snow man's body to keep it whole, so nature uses protein to build up the wasted materials of animal bodies.

Let us next consider the carbohydrates. Sometimes the words *starchy foods* are used to describe the carbohydrates. You have long known forms of these in the white material of corn and of potatoes. The carbohydrates are formed of three elements, — carbon, oxygen, and hydrogen. The office of this whole group of food is to furnish to animal bodies either heat or energy or to enable them to store fat.

In the next place, let us look at the fat in plant food. This consists of the oil stored up in the seeds and other parts of the plant. The grains contain most of the oil. Fat is used by the animal to make heat and energy or to be stored away in the body.

The next animal food in the plant that we are to think about is the mineral matter. The ashes of a burnt plant furnish a common example of this mineral matter. The animal uses this material in the plant to make bone, teeth, and tissue.

The last thing that the plant furnishes the animal is water, — just common water. Young plants contain comparatively large quantities of water. This is one reason why young plants are soft, juicy, and palatable. But, since animals get their water chiefly in another way, the water in feeding stuffs is not important.

What these Compounds do in the Body

Protein

1. Builds flesh, bone, blood, internal organs, hair, and milk.
2. It may be used to make fat.
3. It may be used for heat.
4. It may be used to produce energy.

Carbohydrates

1. To furnish body heat.
2. To furnish energy.
3. To make fat.

Fat

1. To furnish body heat.
2. To furnish energy.
3. To furnish body fat.

Mineral Matter

To furnish mineral matter for the bones in the body.

Water

To supply water in the body.

Average Digestible Nutrients in American Feeding Stuffs

Feeding Stuffs	Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein	Carbohydrates	Fat
Corn stover (field cured)	59.5	1.7	32.4	0.7
Timothy hay	86.8	2.8	43.4	1.4
Soja bean hay	88.7	10.8	38.7	1.5
Oat straw	90.8	1.2	38.6	0.8
Red clover hay	84.7	6.8	35.8	1.7
Alfalfa hay	91.6	11.0	39.6	1.2
Cowpea hay	89.3	10.8	38.6	1.1
Pea-vine straw	86.4	4.3	32.3	0.8
Corn ensilage	20.9	0.9	11.3	0.7
Crab grass	89.3	2.4	47.1	.6
Cow's milk	12.8	3.6	4.9	3.7
Skimmed milk	9.6	3.1	4.7	0.8
Buttermilk	9.9	3.9	4.0	1.1
Oat hay	91.1	4.3	46.4	1.5

Average Digestible Nutrients in American Feeding Stuffs

Feeding Stuffs	Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds		
		Protein	Carbo-hydrates	Fat
Corn	89.1	7.9	66.7	4.3
Corn and cob meal	84.9	4.4	60.0	2.9
Gluten meal	91.8	25.8	43.4	11.
Gluten feed	92.2	20.4	48.4	8.8
Wheat	89.5	10.2	69.2	1.7
Wheat bran	88.1	12.2	39.2	2.7
Wheat middlings	87.9	12.8	53.0	3.4
Rye	88.4	9.9	67.6	1.1
Barley	89.1	8.7	65.6	1.6
Oats	89.0	9.2	47.3	4.2
Rice	87.6	4.8	72.2	0.3
Rice hulls	91.8	1.6	44.5	0.6
Rice bran	90.3	5.3	45.1	7.3
Kaffir corn	84.8	7.8	57.1	2.7
Cotton seed	89.7	12.5	30.0	17.3
Cotton-seed meal	91.8	37.2	16.9	12.2
Cotton-seed hulls	88.9	0.3	33.1	1.7
Peanut meal	89.3	42.9	22.8	6.9
Soja beans	89.2	29.6	22.3	14.4
Cowpeas	85.2	18.3	54.2	1.1
Linseed meal (new)	89.9	28.2	40.1	2.8
Brewer's grain (dry)	91.8	15.7	36.3	5.1

CHAPTER IX

FARM DAIRYING

SECTION XLVII—THE DAIRY COW

Success in dairy farming depends largely upon proper feeding of stock. There are two questions that the dairy farmer should always ask himself: first, Am I feeding as cheaply as I can? second, Am I feeding the best rations for milk and butter production? Of course cows can be kept alive and in fairly good milk flow upon many different kinds of food; but in feeding, as in everything else, there is an ideal to be sought.

What, then, is an ideal ration for a dairy cow? Before trying to answer this question, the word *ration* needs to be explained. By ration is meant a sufficient quantity of food to properly support an animal for one day. If the animal is to have a proper ration, we must bear in mind what the animal needs in order to be best nourished. To get material for muscle, for blood, for milk, and for some other things, the animal needs, in the first place, food that contains protein. To keep warm, to get the necessary amount of fat, etc., the animal must, in the second place, have food containing carbohydrates and fats. These foods must be mixed in right proportions.

With these facts in mind we are prepared for an answer to the question, What is an ideal ration?

First, it is a ration that, without waste, gives both in weight and bulk of dry matter a sufficient amount of digestible, nutritious food.

Second, it is a ration that is comparatively cheap.

Third, it is a ration in which the milk-forming (protein) food is rightly proportioned to the heat and fat-making

FIG. 194. MILKING TIME

(carbohydrates and fat) food. Any ration in which this proportion is neglected is badly balanced.

Now test one or two commonly used rations by these rules. Would a ration of cotton-seed meal and cotton-seed hulls be a model ration? No. Such a ration, since the seeds are grown at home, would be cheap enough. However, it is badly balanced, for it is too rich in protein; hence it is a wasteful ration. Would a ration of corn meal and corn stover be a desirable ration? This, too, since the corn is home-grown, would be cheap for the farmer; but like the other

it is badly balanced, for it contains too much carbohydrate food. This excess of fatty food makes it also wasteful.

A badly balanced ration does harm in two ways: first, the milk flow of the cow is lessened by such ration; second, the cow does not profitably use the food that she eats.

The following table gives an excellent dairy ration for the farmer who has a silo. If he does not have a silo, some other food can be used in place of the ensilage. The table also shows what each food contains. As you grow older, it will pay you to study such tables most carefully.

Feeding Stuffs	Digestible Matter			
	Dry Matter	Protein	Carbo-hydrates	Fat
Cowpea hay = 15 pounds . . .	13.50	1.62	5.79	.16
Corn stover = 10 pounds . . .	5.05	.17	3.24	.07
Corn ensilage = 30 pounds . . .	6.27	.27	3.39	.21
Cotton-seed meal = 2 pounds . .	1.83	.74	.33	.24
Total = 57 pounds . . .	27.56	2.80	12.75	.68

Send to the Secretary of Agriculture, Washington, D.C., for a valuable free bulletin on feeding animals.

Care of the Cow. As the cow is one of the best money-makers on the farm, she should, for this reason, if for no other, be comfortably housed, well fed and watered, and most kindly treated. In your thoughts for her well-being, bear the following directions in mind:

1. If you are not following a balanced ration, feed each day several different kinds of food. In this way you will be most likely not to waste food.

2. Feed at regular hours. Cows, like people, thrive best when their lives are orderly.

3. Milk at regular hours.

4. Brush the udder carefully with a moist cloth before you begin to milk. Cleanliness in handling makes the milk keep longer.

5. Always milk in buckets or cups that have been scalded since the last using. The hot water kills the bacteria that collect in the dents or cracks of the utensil.

FIG. 195. DAIRY

6. Never let the milk pail remain in the stable. Milk rapidly absorbs impurities. These spoil the flavor and cause the milk to sour.

7. Never scold nor strike the cow. She is a nervous animal, and rough usage checks the milk flow.

SECTION XLVIII — MILK, CREAM, CHURNING, AND BUTTER

Milk. Milk is, as you know, nature's first food for mammals. This is because milk is a model food: it contains water to slake thirst, ash to make bone, protein to make flesh and muscle, fat and sugar to keep the body warm and to furnish energy.

The Different Kinds of Milk. (1) Whole, or unskimmed, milk, (2) skimmed milk, (3) buttermilk, are too familiar to need description. When the cow is just fresh, milk is called *colostrum*. This colostrum is rich in the very food that the baby calf needs. After the calf is a few days old, colostrum changes to what is commonly known as milk.

The following table shows the composition of each of the different forms of milk.

Composition of Milk	Digestible Matter in 100 Pounds			
	Dry Matter	Protein	Carbo-hydrates	Fat
Colostrum	25.4	17.6	2.7	3.6
Milk (unskimmed)	12.8	3.6	4.9	3.7
Skimmed milk	9.4	2.9	5.2	1.3
Buttermilk	9.9	3.9	4.0	1.1

A noticeable fact in this table is that skimmed milk differs from unskimmed mainly in the withdrawal of the fat. Hence, if calves are fed on skimmed milk, some food, like corn meal, should be given them to take the place of the fat withdrawn. The calf cannot thrive on skimmed

milk alone. The amount of nourishing fat that a calf gets out of enough milk to make a pound of butter can be bought, in the form of linseed or corn meal, for one or two cents, while the butter fat is worth, for table use, twenty-five cents. Of course, then, it is not economical to allow calves to use unskimmed milk. Some people undervalue skimmed milk; with the addition of some fatty food, it makes an excellent ration for calves, pigs, and fowls.

Fig. 196. Sunning the Cans

Cream. Cream is simply a mixture of butter fat and milk. The butter fat floats in the milk in little globe-shaped bodies, or globules. Since these globules are lighter than milk, they rise to the surface. Skimming the milk is a mere gathering together of these butter fat globules. As most of the butter fat is contained in the cream, pains should be taken to get all the cream from the milk.

After the cream has been collected, it must be allowed "to ripen" or "to sour" in order that it may be more easily churned. Churning is only a second step to collect in a compact shape the fat globules. It often happens that at

FIG. 197. A HAND SEPARATOR

churning time the cream is too warm for successful separation of the globules. Whenever this is the case, the cream must be cooled.

The Churn. Revolving churns without inside fixtures are best. Hence, in buying, select a barrel or a square

box churn. This kind of churn "brings the butter" by the falling of the cream from side to side as the churn is revolved. Never fill the churn more than one third or one half full of cream. A small churn is always to be avoided.

Churning. The proper temperature for churning ranges from 58° to 62° Fahrenheit. Test the cream when it is put into the churn. If it be too cold, add warm water until the proper temperature is reached; if too warm, add cold water or ice until the temperature is brought down to 62°. Do not churn too long, for this spoils butter. As soon as the granules of butter are somewhat smaller than grains of wheat, stop the churn. Then draw off the buttermilk, and at a temperature as low as 50° wash the butter in the churn. This washing with cold water so hardens the granules that they do not mass too solidly and thus destroy the grain.

FIG. 198. A POWER CHURN

Butter. The butter thus churned is now ready to be salted. Use good, fine dairy salt. Coarse barrel salt is not fit for butter. The salt can be added while the butter is still in the churn or after it is put upon the butter-worker. Never work by hand. The object of working is to get the

salt evenly distributed and to drive out some of the brine. It is usually best to work butter twice. The two workings bring about a more even mixture of the salt and drive off more water. But one cannot be too particular not to overwork butter. Delicate coloring, attractive stamping, and proper covering with paper cost little, and of course add to the ready and profitable sale of butter.

FIG. 199. SILO AND HERD

DAIRY RULES

The Stable and Cows

1. Whitewash the stable once or twice each year; use land plaster, muck, or loam daily in the manure gutters.
2. On their way to pasture or milking place, do not allow the cows to be driven at a faster gait than a comfortable walk.
3. Give abundance of pure water.
4. Do not change feed suddenly.
5. Keep salt always within reach of each cow.

Milking

1. Milk with dry hands.
2. Never allow the milk to touch the milker's hands.
3. Require the milker to be clean in person.
4. Milk quietly, quickly, thoroughly. Never leave a drop of milk in the cow's udder.
5. Do not allow cats, dogs, or other animals around at milking time.

The Utensils

1. Use only tin or metal cans and pails.

2. See that all utensils are scrupulously clean and free from rust.

3. Require all cans and pails to be scalded immediately after they are used.

4. After milking, keep utensils inverted in pure air, and sun them, if possible, until wanted for use.

5. Always sterilize the churn with steam or boiling water before and after churning. This prevents any odors or bad flavors from affecting the butter.

SECTION XLIX — HOW MILK SOURS

On another page I have told you how the yeast plant grows in cider and causes it to sour, and how bacteria sometimes cause disease in animals and plants. Now I

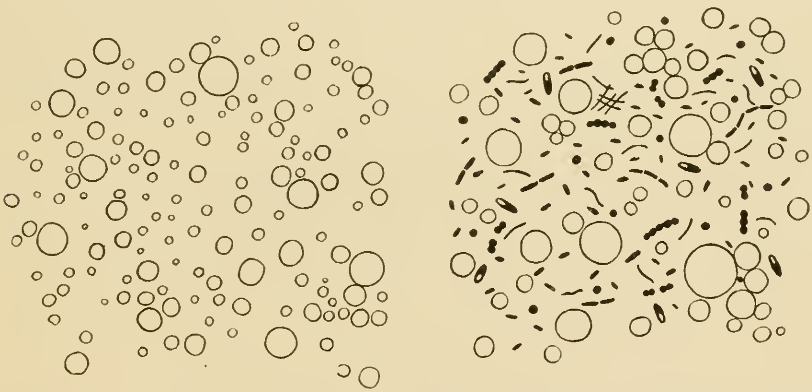

FIG. 200. MICROSCOPIC APPEARANCE OF PURE AND IMPURE MILK

First, pure milk; second, milk after standing in a warm room for a few hours in a dirty dish, showing, besides the fat globules, many forms of bacteria

want to tell you what these same living forms have to do with the souring of milk, and maybe I can also suggest how you can prevent your milk from souring. In the first

place, milk sours because bacteria from the air fall into the milk, begin to grow, and very shortly change the sugar of the milk to an acid. When this acid becomes abundant, the milk begins to curdle. As I have said, the bacteria are in the air, in water, in barn dust; they stick on bits of hay and to the cow. They are most plentiful, however, in milk that has soured; hence, if we pour a little sour milk into a pail of fresh milk, the fresh milk will sour very quickly, because we have, so to speak, "seeded" or "planted" the fresh milk with the souring germs. No one, of course, ever does this purposely in the dairy, yet people sometimes do what amounts to the same thing, — that is, put fresh milk into poorly cleaned pails or pans, the cracks and corners of which are cosy homes for millions of germs left from the last sour milk contained in the vessel. It follows, then, that all utensils used in the dairy should be thoroughly scalded so as to kill all germs present, and particular care should be taken to clean the cracks and crevices, for in them the germs lurk.

In addition to this thorough cleansing with hot water, we should be careful never to stir up the dust of the barn just before milking. Such dusty work as pitching hay or stover or arranging bedding should be done either long before or after milking time, for more germs fall into the milk if the air be full of dust.

To further avoid germs, the milker should wear clean overalls, should have clean hands, and above all should never wet his hands with milk. This last habit, in addition to being filthy, lessens the keeping power of the milk. The milker should also moisten the parts of the cow nearest him, so that dust from the cow's sides may not fall into

the milker's pail. For greater cleanliness and safety many milkmen curry their cows.

The first few streams from each teat should be thrown away, because the teat at its mouth is filled with milk which, being exposed to the air, is full of germs, and will do much toward souring the other milk in the pail. Barely a gill will be lost by throwing the first drawings away, and this of the poorest milk too. The increase in the keeping quality of the milk will much more than repay the small loss. If these precautions are taken, the milk will keep several hours or even days longer than milk carelessly handled. By taking these steps to prevent germs from falling into the milk, a can of milk was once kept sweet for thirty-one days.

The work of the germ in the dairy is not, however, confined to souring the milk. It is the germ that gives to the different kinds of cheeses their characteristic flavors and to the butter its flavor. If the right germ is present, cheese or butter gets a proper flavor. Sometimes undesirable germs gain entrance and give flavors that we do not like. Such germs produce cheese or butter diseases. "Bitter butter" is one of these diseases. To keep out all unpleasant meddlers, thoroughly cleanse and scald every utensil.

EXERCISE

What causes milk to sour? Why do unclean utensils affect the milk? How should milk be cared for to prevent its souring? Prepare two samples, one carefully, the other carelessly. Place them side by side. Which keeps longer? Why? Write to the Department of Agriculture for Farmers' Bulletin, No. 63, on "Care of Milk on the Farm."

SECTION I — GROWING FEEDING STUFFS ON THE FARM

Economy in raising live stock demands the production of all "roughness" or roughage materials on the farm. By roughness, or roughage, of course you understand bulky food, like hay, grass, clover, stover, etc. It is possible to purchase all roughage materials and yet make a financial success of growing farm animals, but this certainly is not the surest way to succeed. Every farm should raise all its feed stuff. In deciding what forage and grain crops to grow we should decide upon:

1. The crops best suited to our soil and climate.
2. The crops best suited to our line of business.
3. The crops that will give us most protein.
4. The crops that produce the most.
5. The crops that will keep our soil in best condition.

1. *Crops best suited to our soil and climate.* Farm crops, as every child of the farm knows, are not equally adapted to all soils and climates. Cotton cannot be produced where the climate is cool and the seasons short. Timothy and blue grass are most productive on cool, limestone soils. Cowpeas demand warm, dry soils. But in spite of climatic limitations, nature has been generous in the wide variety of forage she has given us. If we do our part, there will be no difficulty in providing all the roughage material necessary for the successful rearing of live stock.

Our aim should be to make the best use of what we have, to improve by selection and care those species best adapted

to our soil and climate, and by better methods of growing and curing to secure greatest yields at least possible cost.

2. *Crops best suited to our line of business.* A farmer necessarily becomes a specialist: he gathers those kinds of live stock about him which he likes best and which he finds most profitable. He should, in carrying on his business, do the same with crops.

The successful railroad manager determines by practical experience what distances his engines and crews ought to

FIG. 201. FEEDING TIME

run in a day, what coal is most economical for his engines, what schedules best suit the needs of his road, what trains pay him best. These and a thousand and one other matters are settled by the special needs of his road.

Ought the man who wants to make his farm pay be less prudent and less far-sighted? Ought he not to know his farm as the railroad manager knows his road? Should not

his past failures and his past triumphs decide his future? If he be a dairy farmer, ought he not by practical tests to settle for himself not only what crops are most at home on his land but also what crops in his circumstances yield him the largest returns in milk and butter? If swine raising be his business, how long ought he to guess what crop on his land yields him the greatest amount of hog food? Should a colt be fed on one kind of forage when the land that produced that forage would produce twice as much equally good forage of another kind? All these questions the prudent farmer should answer promptly and in the light of wise experiments.

3. *Crops that will give us most protein.* It is the farmer's business to grow all the grass and forage that his farm animals need. He ought never to be obliged to purchase a bale of forage. Moreover, he should grow mainly those kinds of crops that are rich in protein materials, such for example as cowpeas, alfalfa, and clover. If these kinds of crops are produced on the farm, there will be little need of buying cotton-seed meal, corn, and bran, for feeding purposes.

4. *Crops that produce the most.* We often call a crop a crop without considering how much it yields. This is a mistake. We ought to grow, when we have choice of two, the one that is the best and most productive. Corn, for instance, yields at least twice the quantity of feeding material an acre that timothy does.

5. *Crops that will keep our soil in best condition.* A good farmer should always be thinking of improving his soil. He wants his land to support him, and to maintain his children after he is dead.

Fig. 202. Tools and Machines Properly Protected

Fig. 203. Tools and Machines Unprotected

Since cowpeas, clover, and alfalfa add atmospheric nitrogen to the soil and at the same time are the best feeding materials, it follows that these crops should hold an important place in every system of crop rotation. By proper rotating, by proper terracing, and by proper drainage, land may be made to retain its fertility for generations.

QUESTIONS

1. Why are cowpeas, clover, and alfalfa so important to the farmer?
2. What is meant by the protein of a food?
3. Why is it better to feed farm crops on the farm to animals rather than sell these crops?

SECTION LI — FARM TOOLS AND MACHINES

The drudgery of farm life is diminished in a large measure by the constant invention or improvement of farm tools and machines. You each know, perhaps, how tiresome is the old up-and-down churn dasher that has now pretty generally given place to the "quick coming" churns. The toothed, horse-drawn cultivator has about displaced "the man with the hoe." The grass sickle, slow and back-breaking, is everywhere getting out of the way of the horse mower and rake. The old heavy, sweat-drawing grain cradle is slinking into the backwoods, and in its place we have the horse, or steam-drawn harvester that cuts and binds the grain, and even threshes and measures it at one operation. Instead of the plowman wearily making one furrow at a time, the gang plows of the plains cut many furrows at one time, and instead

Fig. 204. The Harvester at Work

Fig. 205. In Need of Improvement

of walking the plowman rides. The shredder and husker turns the hitherto useless cornstalk into savory food, and at the same time husks, or shucks, the corn.

The farmer of the future must know three things well: first, what machines he can profitably use; second, how to manage these machines; third, how to care for these machines.

This machinery that makes farming so much more economical, and that makes the farmer's life so much easier and more comfortable, is too complicated to be put into the hands of bunglers who will soon destroy it, and it is too costly to be left in the fields or under trees to rust and rot.

If it is not convenient for every farmer to have a separate tool house, he should at least set apart a room in his barn or a shed for storing his tools and machines. As soon as a plow, harrow, cultivator — indeed any tool or machine — has finished its share of work for the season, it should receive whatever attention it needs to prevent rusting, and be carefully housed.

Such care, which is neither costly nor burdensome, will add many years to the life of the machine.

SECTION LII — BIRDS

What do birds do in the world? is an important question for us to think about. First, we must gain by observation and by personal acquaintance with the living birds a knowledge of their work and their way of doing it. In getting this knowledge, let us also consider what we can do for our birds to render their work as complete and effective as possible.

Think of what the birds are doing on every farm, in every garden, and about every home in the land. Think of the millions of beautiful wings, of the graceful and attractive figures, of the cunning nests, and of the singing throats! Do you think that the whole service of the birds is to be beautiful, to sing beautifully, and to rear their little ones? By no means is this their chief service to man. Aside from these values, their greatest work is to destroy insects. It is one of the wise provisions of nature that many of the most brilliantly winged and the most enchanting songsters are our most practical friends.

FIG. 206. A KINGBIRD

Not all birds feed upon insects and animals; but even those that eat but a small amount of insect food may still destroy insects that would have damaged fruit and crops much more than the birds themselves do.

As to their food, birds are divided into three general classes. First, those that live wholly or almost wholly upon insects. These are called insectivorous birds. Chief among these are the warblers, cuckoos, swallows, martins, flycatchers, night hawks, whippoorwills, swifts, and humming birds. We cannot have too many of these birds. They should be encouraged and protected. They should be supplied with shelter and water.

Birds of the second class feed by preference upon fruits, nuts, and grain, — the bluebird, robin, wood thrush, mocking bird, catbird, chickadee, cedar bird, meadow lark, oriole, jay, crow, and woodpecker belong to this group. Those that winter with us — the chickadee, nuthatch, brown creeper, and woodpecker — perform a service for us by devouring many weed seeds.

The third class is known as hard-billed birds. It includes those birds that live principally upon seeds and grain, — the canary, goldfinch, sparrows, and some others.

Birds that come early, like the bluebird, robin, and redwing, are of special service in destroying insects before the insects lay their eggs for the season.

The robins on the lawn search out the caterpillars and cutworms. The chipping sparrow and the wren in the shrubbery look out for all kinds of insects. They watch over the orchard and feed freely upon the enemies of the apple and other fruit trees. The trunks of these trees are often attacked by borers, which gnaw holes in the bark and wood, and often cause the death of the trees. The woodpeckers hunt for these appetizing borers and by means of their barbed tongues bring them from their hiding places. On the outside of the bark of the trunk and branches the bark lice work. These are devoured by the nuthatches, creepers, and chickadees.

In winter, the bark is the hiding place for hibernating insects, like plant lice, which in summer feed upon the leaves. Throughout the winter a single chickadee will destroy immense numbers of the eggs of the cankerworm moth and the plant louse. The blackbirds, meadow larks, crows, quail, and sparrows are the great protectors of the

meadow and field crops. These birds feed upon the army worms and cutworms that do so much injury to the young shoots; they also destroy the chinch bug and the grasshopper, both of which feed upon cultivated plants.

A count of all the different kinds of animals shows that insects make up nine tenths of the animals. Hence it is easy to see that if something did not check their increase they would soon almost take the earth. Our forests and orchards furnish homes and breeding places for most of these insects. Suppose the injurious insects were allowed to multiply unchecked in these forests, their numbers would so increase that they would invade our fields and create as much terror among the farmers as they did in Pharaoh's Egypt. The birds are the only direct friends man has to destroy these harmful insects. What benefactors, then, these little feathered neighbors are!

FIG. 207. A WARBLER

It has been estimated that a bird will devour thirty insects daily. Even in a widely extended forest region a very few birds to the acre, if they kept up this rate, would daily destroy many bushels of insects that would play havoc with neighboring orchards and fields.

Do not imagine, however, that to destroy insects is the only use of birds. By care we can surround ourselves with a world of birds, sweet of song and brilliant of plumage. Surely the day is more charmingly spent when the birds sing, and when they flit in and out, giving us a glimpse now and then of their pretty coats and quaint ways.

FIG. 208. THE HAIRY WOODPECKER

If the birds felt that man was a friend and not a foe, they would often turn to him for protection. During times of severe storm, extreme drought, scarcity of food, if the birds were sufficiently tamed to come to man as their friend as they do in rare cases now, a little food and shelter might tide them over the hard time and their service afterward would repay the outlay a thousand-fold. If the boys in your families would build bird houses about the house and barn and in shade trees, they might save yearly a great number of birds. In building these places of shelter and comfort, due care must be taken to keep them clear of English sparrows and out of the reach of cats and bird dogs.

Whatever we do to attract the birds to make homes on the premises must be done at the right time and in the

right way. We must know what materials to provide for them. Bits of string, linen, cotton, yarn, tow, all help to induce a pair to build in the garden.

It is an interesting study, — the preparation of homes for the birds. Trees may be pruned to make inviting crotches. A tangled, overgrown corner in the garden will invite some birds to nest.

Wrens, bluebirds, chickadees, martins, and some other varieties are all glad to set up housekeeping in man-made houses. The proper size for a bird room is easily remembered. Give each room six square inches of floor space

FIG. 209. PROTECTING OUR FRIENDS

From Hodge's "Nature Study and Life," Ginn & Company

and make it eight inches high. Old, weathered boards should be used; or, if paint is employed, a dull color to resemble an old tree trunk will be most inviting. A single opening near the top should be made two inches

in diameter for the larger birds; but if the house is to be headquarters for the wren, a one-inch opening is quite large enough and the small door serves all the better to keep out English sparrows.

The barn attic should be turned over to the swallows. Small holes may be cut high up in the gables and left open during the time that the swallows remain with us. They will more than pay for shelter by the good work they do in ridding the barn of flies, gnats, and mosquitoes.

SECTION LIII — LIFE IN THE COUNTRY

As ours is a country in which the people rule, every boy and every girl ought to be trained to take a wide-awake interest in public affairs. This training cannot begin too early in life. A wise old man once said, "In a republic you ought to begin to train a child for good citizenship on the day of its birth."

Happy would it be for our nation if all the young people who live in the country could begin their training in good citizenship by becoming workers for these four things:

First, attractive country homes.

Second, attractive country schoolhouses and grounds.

Third, good country schools.

Fourth, good roads.

If the thousands upon thousands of pupils in our schools would become active workers for these things, and continue their work through life, then, in less than half a century, life in the country would be an unending delight.

One of the problems of our day is how to keep bright, thoughtful, sociable, ambitious boys and girls contented on

FIG. 210. BEAUTY FROM FLOWERS AND GRASS

FIG. 211. A MECKLENBURG COUNTY, NORTH CAROLINA, COUNTRY ROAD

From a photograph furnished by the United States Department of Agriculture

the farm. Every step taken to make the country home more attractive, to make the school and its grounds more enjoyable, to make the way easy to homes of neighbors, to school, to post office, to church, is a step taken towards keeping on the farm the very boys and girls who are most apt to succeed there.

Not every man who lives in the country can have a showy or costly home, but as long as grass and flowers and vines and trees grow, any man who wishes can have an inviting-looking house. Not every woman who is to spend a lifetime at the head of a rural home can have a luxuriously furnished home, but any woman who is willing to take a little trouble can have a cozy, tastefully furnished home, a home fitted with the conveniences that diminish household drudgery. Even in this day of cheap literature, all parents cannot fill their children's home with papers, magazines, and books, but by means of school and Sunday-school libraries, by means of circulating book clubs, and by a little self-denial, earnest parents can feed hungry minds just as they feed hungry bodies.

Agricultural papers that arouse the interest and quicken the thought of farm boys by discussing the best, easiest, and cheapest ways of farming; journals full of dainty suggestions for household adornment and comfort; illustrated papers and magazines that amuse and brighten every member of the family; books that rest tired bodies, — all of these are so cheap that the money reserved from the sale of one hog will keep a family fairly supplied for a year.

If the parents, teachers, and pupils of a school join hands, an unsightly, ill-furnished, ill-lighted, ill-ventilated

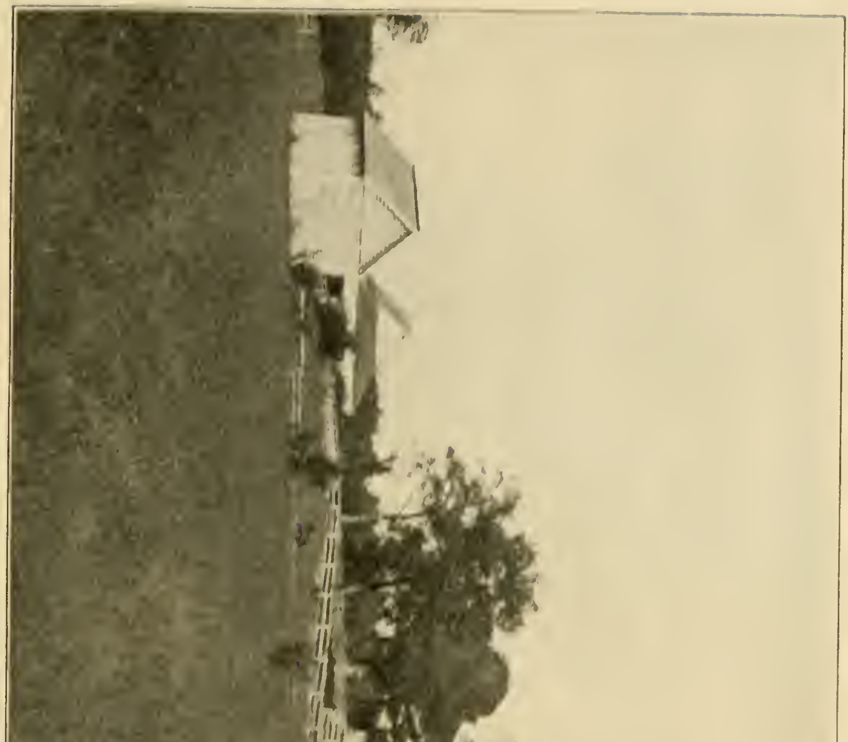

FIG. 212. AN ATTRACTIVE COUNTRY HOME

schoolhouse can at small cost be changed into one of comfort and beauty. In many places pupils have persuaded their

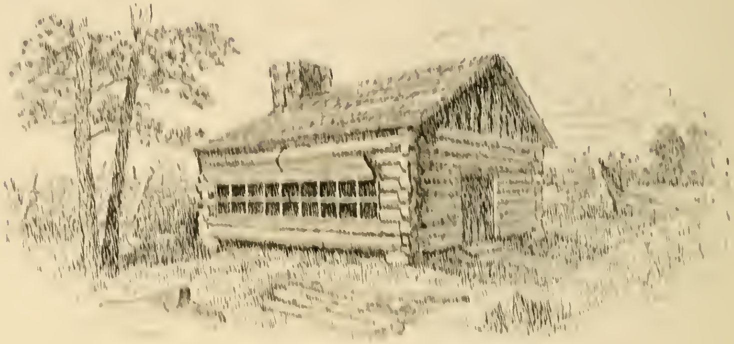

FIG. 243. AN UNIMPROVED SCHOOLHOUSE

parents to form clubs to beautify the school grounds. Each father sends a man or a man with a plow, once or twice a year to work a day on the grounds. Stumps are removed, trees trimmed, drains put in, grass sown, flowers, shrubbery,

FIG. 244. AN IMPROVED SCHOOLHOUSE

vines, and trees planted, and the grounds tastefully laid off. Thus at scarcely noticeable money cost a rough and

FIG. 215 THE SAME ROAD AFTER AND BEFORE IMPROVEMENT

From photographs furnished by the United States Department of Agriculture

unkempt school ground gives place to a charming campus. Cannot the pupils in every school in which this book is studied get their parents to form such a club, and make their school ground a silent teacher of neatness and beauty?

Life in the country will never be as attractive as it ought to be until all the roads are improved. Winter-washed roads, penning young people in their own homes for many months each year and destroying so many of the innocent pleasures of youth, build towns and cities out of the wreck of country homes. Can young people who love their country and their country homes engage in a nobler crusade than a crusade for improved highways?

APPENDIX

SPRAYING MIXTURES

FOR BITING INSECTS

Dry Paris Green		Wet Paris Green	
Paris green	1 lb.	Paris green .	¼ lb.
Lime or flour	20 to 50 lbs.	Lime . . .	¼ to ½ lb.
		Water	50 gals.

FOR SOFT-BODIED SUCKING INSECTS

Kerosene Emulsion

Hard soap (in fine shavings)	½ lb.
Water	1 gal.
Kerosene	2 gals.

Dissolve soap in boiling water, add kerosene to the hot water, churn with spraying pump until the mixture changes to a creamy, then to a soft, butterlike mass. This gives three gallons of 66 per cent oil emulsion which may be diluted to the strength desired. To get 15 per cent oil emulsion add ten and one half gallons water.

FOR FUNGOUS DISEASES

Copper Sulphate

Copper sulphate	1 lb.
Water	18 to 25 gals.

Use only before foliage opens to kill wintering spores.

Bordeaux Mixture

Copper sulphate	5 lbs.
Lime (good and unslacked)	5 lbs.
Water	50 gals.

	FIRST	SECOND
Apple, Pear, and Quince. — Scab, codling moth, tent caterpillar, canker-worm.	Before buds swell, copper sulphate.	Immediately before blossoms open, Bordeaux Mixture.
Bean. — Leaf blight and spots.	When second leaf opens, Bordeaux Mixture.	10 to 14 days later, Bordeaux Mixture.
Cabbage, Cauliflower, etc. — Lice and worm.	As often as needed till plants begin to head, kerosene emulsion.	
Carnation. — Rust and other diseases.	As needed, copper sulphate, 1 lb. to 25 gals. every 8 to 14 days.	
Celery. — Blights and spots.	Begin in seed bed, Bordeaux Mixture, 8 to 14 days, or often enough to keep foliage covered.	
Cherry. — Rot.	As buds break, Bordeaux Mixture.	Bordeaux Mixture.
Cucumber, Squash, and Melon. — Mildew and beetle.	Often enough to keep foliage covered, Bordeaux-Paris-green mixture.	
Grape. — Mildew, anthracnose, black rot, etc.	When buds swell, Bordeaux Mixture.	Just before flowers open, Bordeaux-Paris-green mixture.
Nursery Stock. — Fungous diseases.	When leaves appear, Bordeaux-Paris green mixture, repeat every 10 to 14 days.	
Peach and Plum. — Rot, mildew, and curl.	Before foliage, copper sulphate, 1 lb. to 25 gals.	Before blossoms open, weak Bordeaux Mixture.
Potato. — Early and late blight and bug.	When two thirds grown, Bordeaux Mixture.	Repeat Bordeaux Mixture every two or three weeks; add Paris green, when needed, for bugs.
Grain. — Smuts.	See text.	

Send to your Experiment Station for

THIRD	FOURTH	REMARKS
Immediately after blossoms fall, Bordeaux-Paris-green mixture.	8 to 14 days later, Bordeaux-Paris-green mixture.	For scale, see text; for fire blight and canker, cut and burn; add Paris green when needed for cankerworms.
10 to 14 days later, Bordeaux Mixture.	Repeat Bordeaux Mixture when needed.	
		For the worm, use dry Paris green with lime or flour, 1 oz. to 6 lbs. Do not use after plants begin to head.
When fruit is grown, ammoniacal copper carbonate.		For lice, kerosene emulsion; for black knot, cut and burn.
When fruit sets, Bordeaux-Paris-green mixture.	As fruit enlarges, ammoniacal copper carbonate.	
		For plant lice, kerosene emulsion; for scale, see text.
After blossoms open, weak Bordeaux Mixture.	As fruit enlarges, ammoniacal copper carbonate.	For curculio and for scale, see text.
		For scab, soak seed potatoes before cutting for two hours in formalin, 8 oz. to 15 gals.

more detailed directions for treatment

Dissolve the copper sulphate (bluestone) in twenty-five gallons of water. Slack the lime slowly so as to get a smooth, thick cream. After thorough slacking, add twenty-five gallons of water. When lime and bluestone are dissolved, pour rapidly together and mix thoroughly. Strain through a coarse cloth.

Mix fresh for each time. Use for molds and fungi generally. Apply in fine spray with a good nozzle.

Weak Bordeaux Mixture for Peaches, Plums, and Cherries in Foliage

Mix as above, but in the following proportions:

Copper sulphate	2½ lbs.
Lime	2½ lbs.
Water	50 gals.

Bordeaux-Paris-Green Mixture

Ordinary Bordeaux Mixture	50 gals.
Paris green	4 oz.

Use for both fungi and insects on apple, potato, etc.

Ammoniacal Copper Carbonate

Copper carbonate	5 oz.
Ammonia (26° Baumé)	about 3 pts.
Water	50 gals.

Dissolve the copper carbonate in smallest possible amount of ammonia. This solution may be kept in stock and diluted to proper strength as needed.

Use this instead of the Bordeaux Mixture after the fruit has reached half or two thirds of the mature size. It leaves no spots as does the Bordeaux.

COST OF SPRAYING

Sulphate of copper costs about ten to fifteen cents a pound.

Formalin may be bought from seventy-five to ninety cents a pound.

You can make the Bordeaux Mixture at a cost of a little less than one cent a gallon.

Spraying potatoes costs from three and one half to seven dollars an acre. The cost depends upon the number of applications and the amount of foliage to be covered.

Fruit trees fully grown may be sprayed for from six to twenty cents a season. This includes the cost of labor.

FERTILIZER FORMULAS FOR CORN, COTTON, AND TOBACCO

(These formulas were kindly furnished by Director B. W. Kilgore of the North Carolina Experiment Station.)

Fertilizers for Corn. — For average conditions a fertilizer containing 7 per cent available phosphoric acid, 1½ per cent of potash, and 3 per cent of nitrogen is well suited to corn. The following mixtures furnish these materials in approximately the above proportions:

No. 1

Acid phosphate, 14 per cent phosphoric acid	875 lbs.
Cotton-seed meal, 6.61 per cent nitrogen	950 lbs.
Kainit, 12½ per cent potash	175 lbs.
	2000 lbs.

No. 2

Acid phosphate	1000 lbs.
Fish scrap, 8¼ nitrogen	750 lbs.
Kainit	250 lbs.
	2000 lbs.

No. 3

Acid phosphate	1000 lbs.
Fish scrap	920 lbs.
Muriate of potash, 50 per cent potash	80 lbs.
	2000 lbs.

No. 4

Acid phosphate	950 lbs.
Cotton-seed meal	1000 lbs.
Muriate of potash	50 lbs.
	2000 lbs.

No. 5

Acid phosphate	1250 lbs.
Dried blood, 13 per cent nitrogen	650 lbs.
Muriate of potash	100 lbs.
	2000 lbs.

Fertilizers for Cotton. — A fertilizer containing 7 per cent available phosphoric acid, 2½ per cent of potash, and 2½ per cent of nitrogen is well suited to cotton. The following mixtures furnish these materials in approximately the above proportions:

No. 1

Acid phosphate, 14 per cent phosphoric acid	900 lbs.
Cotton-seed meal, 6.6 per cent nitrogen	800 lbs.
Kainit, 12½ per cent potash	300 lbs.
	2000 lbs.

No. 2

Acid phosphate	950 lbs.
Fish scrap, 8¼ per cent nitrogen	650 lbs.
Kainit	400 lbs.
	2000 lbs.

No. 3

Acid phosphate	1000 lbs.
Cotton-seed meal	925 lbs.
Muriate of potash, 50 per cent potash	75 lbs.
	2000 lbs.

No. 4

Acid phosphate	1075 lbs.
Fish scrap, 8¼ per cent nitrogen	800 lbs.
Muriate of potash	125 lbs.
	2000 lbs.

No. 5

Acid phosphate	1250 lbs.
Dried blood, 13 per cent nitrogen	600 lbs.
Muriate of potash	150 lbs.
	2000 lbs.

Fertilizers for Tobacco. — For average conditions a fertilizer containing 6 per cent available phosphoric acid, 2½ per cent potash, and 2½ per cent of nitrogen is well suited to tobacco. The following mixtures furnish these materials in approximately the above proportions:

No. 1

Cotton-seed meal	900 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	250 lbs.
Acid phosphate, 14 per cent	750 lbs.
	2000 lbs.

No. 2

High-grade dried blood	500 lbs.
Nitrate of soda	125 lbs.
High-grade sulphate of potash	310 lbs.
Acid phosphate	1065 lbs.
	2000 lbs.

No. 3

Fish scrap	725 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	300 lbs.
Acid phosphate	875 lbs.
	2000 lbs.

No. 4

Dried blood	500 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	400 lbs.
Acid phosphate	1000 lbs.
	2000 lbs.

No. 5

Cotton-seed meal	700 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	300 lbs.
Acid phosphate	900 lbs.
	2000 lbs.

GLOSSARY

To enable young readers to understand the technical words necessarily used in the text only popular definitions are given.

Abdomen: the part of an insect lying behind the thorax.

Acid: a chemical name given to many sour substances. Vinegar and lemon juice owe their sour taste to the acid in them.

Adult: a person, animal, or plant grown to full size and strength.

Ammonia (*ammonium*): a compound of nitrogen readily usable as a plant food. It is one of the products of decay.

Annual: a plant that bears seed during the first year of its existence and then dies.

Anther: the part of a stamen that bears the pollen.

Atmospheric nitrogen: nitrogen in the air. Great quantities of this valuable plant food are in the air; but, strange to say, most plants cannot use it directly from the air, but must take it in other forms, as nitrates, etc. The legumes are an exception, as they can use atmospheric nitrogen.

Available plant food: food in such condition that plants can use it.

Bacteria: a name applied to a number of kinds of very small living beings, some beneficial, some harmful, some disease-producing. They average about one twenty-thousandth of an inch in length.

Balanced ration: a ration made up of the proper amounts of carbohydrates, fats, and protein, as explained in text. Such a ration avoids all waste of food.

Biennial: a plant that produces seed during the second year of its existence and then dies.

Blight: a diseased condition in plants in which the whole or a part of a plant withers or dries up.

Bluestone: a chemical; copper sulphate. It is used to kill fungi, etc.

Bordeaux Mixture: a mixture invented in Bordeaux, France, to destroy disease-producing fungi.

Bud (noun): an undeveloped branch.

Bud (verb): to insert a bud from the scion upon the stock to insure better fruit.

Bud variation: occasionally one bud on a plant will produce a branch differing in some ways from the rest of the branches; this is bud variation. The shoot that is produced by bud variation is called a *sport*.

Calyx: the outermost row of leaves in a flower.

Cambium: the growing layer lying between the wood and the bark.

Canon: the shank bone above the fetlock in the fore and hind legs of a horse.

Carbohydrates: carbohydrates are foods free from nitrogen. They make up the largest part of all vegetables. Examples are sugar, starch, and cellulose.

Carbolic acid: a chemical often used to kill or prevent the growth of germs, bacteria, fungi, etc.

Carbon: a chemical element. Charcoal is nearly pure carbon.

Carbon disulphide: a chemical used to kill insects.

Carbonic acid gas: a gas consisting of carbon and oxygen. It is produced by breathing, and whenever carbon is burned. It is the source of the carbon in plants.

Cereal: the name given to grasses that are raised for the food contained in their seeds, such as corn, wheat, rice.

Cobalt: a poisonous chemical used to kill insects.

Cocoon: the case made by an insect to contain its larva or pupa.

Commercial fertilizer: an enriching plant food bought to improve soil.

Compact: a soil is said to be compact when the particles are closely packed.

Concentrated: when applied to food the word means that it contains much feeding value in small bulk.

Contagious: a disease is said to be contagious when it can be spread or carried from one individual to another.

Cross: the result of breeding two varieties of plant together.

Cross pollination: the pollination of a flower by pollen brought from a flower on some other plant.

Croup: the top of the hips.

Culture: the art of preparing ground for seed and raising crops by tillage.

Curb disease: a swelling on the back part of the hind leg of a horse just behind the lowest part of the hock joint. It generally causes lameness.

Curculio: a kind of beetle or weevil.

Dendrolene: a patented substance used for catching cankerworms.

Digestion: the act by which food is prepared by the juices of the body to be used by the blood.

Dormant: a word used to describe sleeping or resting bodies, — bodies not in a state of activity.

Drainage: the process by which an excess of water is removed from the land by ditches, terraces, or tiles.

Element: a substance that cannot be divided into simpler substances.

Ensilage: green foods preserved in a silo.

Evaporate: to pass off in vapor, as a fluid often does; to change from a solid or liquid state into vapor, usually by heat.

Exhaustion: the state in which strength, power, and force have been lost. When applied to land, the word means that land has lost its power to produce well.

Fermentation: a chemical change produced by bacteria, yeast, etc. A common example of fermentation is the change of cider into vinegar.

Fertility: the state of being fruitful. Land is said to be fertile when it produces well.

Fertilization: the act which follows pollination and enables a flower to produce seed.

Fetlock: the long-haired cushion on the back side of a horse's leg just above the hoof.

Fiber: any fine, slender thread or threadlike substance, as the rootlets of plants or the lint of cotton.

Filter: to purify a liquid, as water, by causing it to pass through some substance, as paper, cloth, screens, etc.

Formalin: a forty per cent solution of a chemical known as formaldehyde. Formalin is used to kill fungi, bacteria, etc.

Formula: a recipe for the making of a compound; for example, fertilizer or spraying compounds.

Fungicide: a substance used to kill or prevent the growth of fungi; for example, Bordeaux Mixture or copper sulphate.

Fungous: belonging to or caused by fungi.

Fungus (plural fungi): a low kind of plant life lacking in green color. Molds and toadstools are examples.

Germ: that from which anything springs. The term is often applied to any very small organism or living thing, particularly if it causes great effects such as disease, fermentation, etc.

Germinate: to sprout. A seed germinates when it begins to grow.

Girdle: to make a cut or groove around a limb or tree.

Glacier: an immense field or stream of ice formed in the region of constant snow and moving slowly down a slope or valley.

Globule: a small particle of matter shaped like a globe.

Glucose: a kind of sugar very common in plants. The sugar from grapes, honey, etc. is glucose. That from the sugar cane is not.

Gluten: a vegetable form of protein found in cereals.

Graft: to place a living branch or stem on another living stem so that it may grow there. It insures the growth of the desired kind of plant.

Granule: a little grain.

Gypsum: land plaster.

"Head back": to cut or prune a tree so as to form its head, that is, the place where the main trunk first gives off its branches.

Heredity: the resemblance of offspring to parent.

Hibernating: to pass the winter in a torpid or inactive state in close quarters.

Hock: the joint in the hind leg of quadrupeds between the leg and the shank. It corresponds to the ankle in man.

Host: the plant upon which a fungus or insect is preying.

Humus: the portion of the soil caused by the decay of animal or vegetable matter.

Hybrid: the result of breeding two different kinds of plants together.

Hydrogen: a chemical element. It is present in water and in all living things.

Individual: a single person, plant, animal, or thing of any kind.

Inoculate: to give a disease by inserting the germ that causes it in a healthy being.

Insectivorous: anything that eats insects.

Kainit: salts of potash used in making fertilizers.

Kernel: a single seed or grain, as a kernel of corn.

Kerosene emulsion: see Appendix.

Larva (plural **larvæ**): the young or immature form of an insect.

Larval: belonging to larva.

Layer: to propagate plants by a method similar to cutting, but differing from cutting in that the young plant takes root before it is separated from the parent plant.

Legume: a plant belonging to the family of the pea, clover, and bean; that is, having a flower of similar structure.

Lichen: a kind of flowerless plant that grows on stones, trees, boards, etc.

Loam: an earthy mixture of clay and sand with organic matter.

Magnesia: an earthy white substance somewhat similar to lime.

Magnify: to make a thing larger in fact or in appearance; to enlarge the appearance of a thing so that the parts may be seen more easily.

Membrane: a thin layer or fold of animal or vegetable matter.

Mildew: a cobwebby growth of fungi on diseased or decaying things.

Mold: see *mildew*.

Mulch: a covering of straw, leaves, or like substances over the roots of plants to protect them from heat, drought, etc., and to preserve moisture.

Nectar: a sweetish substance in blossoms of flowers from which bees make honey.

Nitrate: a readily usable form of nitrogen. The most common nitrate is saltpeter.

Nitrogen: a chemical element, one of the most important and most expensive plant foods. It exists in fertilizers, in ammonia, in nitrates, and in organic matter.

Nodule: a little knot or bump.

Nutrient: any substance which nourishes or promotes growth.

Organic matter: substances made through the growth of plants or animals.

Ovary: the particular part of the pistil that bears the immature seed.

Ovipositor: the organ with which an insect deposits its eggs.

Oxygen: a gas present in the air and necessary to breathing.

Particle: any very small part of a body.

Perennial: living through several years. All trees are perennial.

Petal: a single leaf of the corolla.

Phosphoric acid: an important plant food occurring in bones and rock phosphates.

Pistil: the part of the blossom that contains the immature seeds.

Pollen: the powdery substance borne by the stamen of the flower. It is necessary to seed production.

Pollination: the act of carrying pollen from stamens to pistils. It is usually done by the wind or by insects.

Porosity: the state of having small openings or passages between the particles of matter.

Potash: an important part of plant foods. The chief source of potash is kainit, muriate of potash, sulphate of potash, wood ashes, and cotton-hull ashes.

Propagate: to cause plants or animals to increase in number.

Protein: the name of a group of substances containing nitrogen. It is one of the most important of feeding stuffs.

Pruning: trimming or cutting parts that are not needed or that are injurious.

Pulverize: to reduce to a dustlike state.

Pupa: an insect in the stage of its life that comes just before the adult condition.

Purity (of seed): seeds are pure when they contain only one kind of seed and no foreign matter.

Ration: a fixed daily allowance of food for an animal.

Raupenleim: a patented sticky substance used to catch the cankerworm.

Resistant: a plant is resistant to disease when it can ward off attacks of the disease; for example, some varieties of the grape are resistant to the phylloxera.

Rotation (of crops): a well-arranged succession of different crops on the same land.

Scion: a shoot, sprout, or branch taken to graft or bud upon another plant.

Seed bed: the layer of earth in which seeds are sown.

Seed selection: the careful selection of seed from particular plants with the object of keeping or increasing some desirable quality.

Seedling: a young plant just from the seed.

Sepal: one of the leaves in the calyx.

Silo: a house or pit for packing away green food for winter use so as to exclude air and moisture.

Sire: father.

Smut: a disease of plants, particularly of cereals, which causes the plant or some part of it to become a powdery mass.

Spiracle: an air opening in the body of an insect.

Spore: a small body formed by a fungus to reproduce the fungus. It serves the same use as seeds do for flowering plants.

Spray: to apply a liquid in the form of a very fine mist by the aid of a spraying pump for the purpose of killing fungi or insects.

Stamen: the part of the flower that bears the pollen.

Stamina: endurance.

Sterilize: to destroy all the germs or spores in or on anything. Sterilizing is often done by heat or chemicals.

Stigma: the part of the pistil that receives the pollen.

Stock: the stem or main part of a tree or plant. In grafting or budding the scion is inserted upon the stock.

Stover: as used in this book the word means the dry stalks of corn from which the ears have been removed.

Subsoil: the soil under the topsoil.

Sulphur: a yellowish chemical element; brimstone.

Taproot: the main root of a plant, which runs directly down into the earth to a considerable depth without dividing.

Terrace: a ridge of earth run on a level around a slope or hillside to keep the land from washing.

Thorax: the middle part of the body of an insect. The thorax lies between the abdomen and the head.

Tillage: the act of preparing land for seed, and keeping the ground in a proper state for the growth of crops.

Transplant: a plant grown in a bed with a view to being removed to other soil.

Tubercle: a small, wartlike growth on the roots of legumes.

Udder: the milk vessel of a cow.

Utensil: a vessel used for household purposes.

Variety: a particular kind. For example, the Winesap, Bonum, Æsop, etc., are different varieties of apples.

Ventilate: to open to the free passage of air.

Virgin soil: a soil which has never been cultivated.

Vitality (of seed): vitality is the ability to grow. Seed are of good vitality if a large per cent of them will sprout.

Weathering: the action of moisture, air, frost, etc. upon rocks.

Weed: a plant out of place. A wheat plant in a rose bed or a rose in the wheat field would be regarded as a weed, as would any plant growing in a place in which it is not wanted.

Wilt (of cotton): a disease of cotton in which the whole plant droops or wilts.

Withers: the ridge between the shoulder bones of a horse, at the base of the neck.

Yeast: a preparation containing the yeast plant used to make bread rise, etc.

INDEX

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This is another chapter in the shy, wild life of the fields and woods. Little Tookhees, the wood mouse that dies of fright in the author's hand; the mother otter, Keeonekh, teaching her little ones to swim; and the little red squirrel with his many curious habits, — all are presented with the same liveliness and color that characterize the descriptions in the first two volumes. The illustrations by Charles Copeland are unusually accurate in portraying animal life as it really exists in its native haunts.

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186 pages. Illustrated. List price, 50 cents; mailing price, 60 cents.

The title of this new book suggests the central thought about which the author has grouped some of his most fascinating animal studies. To him "the summer wilderness is one vast schoolroom in which a multitude of wise, patient mothers are teaching their little ones the things they must know in order to hold their place in the world and escape unharmed from a hundred dangers."

This book, also, is adequately illustrated by Charles Copeland.

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DESCRIPTIVE SPELLER

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State Inspector of High Schools for Minnesota
